National Park Service
U.S. Department of the Interior

Natural Resource Program Center

Natural Radionuclides (^{234}Th, ^{7}Be and ^{210}Pb) as Indicators of Sediment Dynamics in Jamaica Bay, New York

Natural Resource Technical Report NPS/NERO/NRTR—2010/324

ON THE COVER
Photograph courtesy of : Alexander Kolker (formerly, Stony Brook University)

Natural Radionuclides (^{234}Th, ^{7}Be and ^{210}Pb) as Indicators of Sediment Dynamics in Jamaica Bay, New York

Natural Resource Technical Report NPS/NERO/NRTR—2010/324

ALISHA A. RENFRO[1], J. KIRK COCHRAN[1], DAVID J. HIRSCHBERG[1],

HENRY J. BOKUNIEWCZ[1], AND STEVEN L. GOODBRED Jr.[2]

[1]School of Marine and Atmospheric Sciences
Stony Brook University
Stony Brook, NY 11794-5000

[2] Present Address:
Department of Earth and Environmental Sciences
Vanderbilt University
Nashville, TN 37240

May 2010

U.S. Department of the Interior
National Park Service
Natural Resource Program Center
Fort Collins, Colorado

The National Park Service, Natural Resource Program Center publishes a range of reports that address natural resource topics of interest and applicability to a broad audience in the National Park Service and others in natural resource management, including scientists, conservation and environmental constituencies, and the public.

The Natural Resource Technical Report Series is used to disseminate results of scientific studies in the physical, biological, and social sciences for both the advancement of science and the achievement of the National Park Service mission. The series provides contributors with a forum for displaying comprehensive data that are often deleted from journals because of page limitations.

All manuscripts in the series receive the appropriate level of peer review to ensure that the information is scientifically credible, technically accurate, appropriately written for the intended audience, and designed and published in a professional manner.

This report received formal peer review by subject-matter experts who were not directly involved in the collection, analysis, or reporting of the data, and whose background and expertise put them on par technically and scientifically with the authors of the information.

Views, statements, findings, conclusions, recommendations, and data in this report are those of the author(s) and do not necessarily reflect views and policies of the National Park Service, U.S. Department of the Interior. Mention of trade names or commercial products does not constitute endorsement or recommendation for use by the National Park Service.

This report is available from http://www.nps.gov/nero/science/ and the Natural Resource Publications Management website (http://www.nature.nps.gov/publications/NRPM).

Please cite this publication as:
Renfro, A., J. K. Cochran, D. J. Hirschberg, and S. L. Goodbred. 2010. Natural radionuclides (^{234}Th, ^{7}Be and ^{210}Pb) as indicators of sediment dynamics in Jamaica Bay, New York. Natural Resource Technical Report NPS/NERO/NRTR—2010/324. Fort Collins, Colorado.

NPS 646/102095, May 2010

Contents

Contents

Figures

Page

Figures

Page

Tables

Tables

Page

Tables

Page

Executive Summary

This study has been motivated by the issue of marsh loss in Jamaica Bay, New York. A deficit in sediment supply has been implicated as a factor in the dramatic marsh loss in the bay, and we have used particle-reactive natural radionuclides as tracers for the transport and deposition of particles in the bay. The short-lived radionuclides 7Be (half-life = 53 d) and 234Th (half-life = 24.1 d) serve as tracers of particle dynamics on short-term (seasonal) time scales, while the longer lived 210Pb (half-life = 22.3 y) traces the fate of particles on decadal time scales. In Jamaica Bay, the well-characterized supply of 7Be and 210Pb from the atmosphere is augmented by inputs of these radionuclides from combined sewer overflow (CSO) events that add storm water to the bay. As well, the supply of 234Th from decay of dissolved 238U in situ is augmented by particles with excess 234Th transported into the bay from the New York Bight. Inventories of excess 234Th in bay sediments show significant temporal variation, as evidenced in four sampling campaigns of the bay carried out in 2004-2006. 234Th is deposited in sediments of the western bay during times of low wave height outside the bay. However, particles and associated 234Th are transported to the northeastern portion of the bay (e.g. Grassy Bay) following storms. We have used a mass balance of 234Th in the bay to estimate an annual input of sediment of 5.6 × 1010 to 6.7 x 1011 g from the New York Bight into the bay. This estimate is ~4 – 45 times greater than those based on sediment balances and extrapolations based on measurement of sediment transport across Rockaway Inlet over a tidal cycle. The difference may be due to the fact that the methods are integrating over different time scales and data characterizing the 234Thxs transported into the bay with particles are limited. However, all estimates agree that there is an import of sediment from New York Bight into Jamaica Bay. We have also used down-core distributions of excess 210Pb to estimate average long-term rates of sediment deposition in the muddy sediments of the bay to be 0.47 ± 0.27 g cm-2 y-1. Both of these radionuclide-based estimates are upper limits.

Measurements of 7Be and 234Th in marsh peat complement the distribution of these radionuclides in subtidal sediments. While 7Be is observed at all sites sampled, as a consequence of its direct supply to the marsh from the atmosphere, the input of 234Th depends on the supply of particles from the subtidal to the marsh surface. Elevated inventories of 234Th are typically observed near marsh edges, although the pattern is complicated by the proximity of interior sites to tidal creeks that serve as conduits for sediment supply to the marsh. Independently measured profiles of 210Pb in several Jamaica Bay marshes (JoCo, Big Egg and East High; Kolker, 2005) show that these marshes are accreting at rates that keep pace with sea level rise. Thus, a lack of sediment supply to the marsh surface does not appear to be the cause of marsh loss in Jamaica Bay. Other factors may be responsible for the inability of marshes to increase their elevation in concert with sea level rise. Such factors include eutrophication of the surrounding waters and build-up of phytotoxins (e.g. hydrogen sulfide) in the marsh peat pore water.

Introduction

The purpose of this study is to use natural radionuclides to study particle transport and deposition in Jamaica Bay, New York, a coastal lagoon that has been heavily impacted by development. Despite decreases in industrial discharges and the banning of products such as phosphorous detergents, lead gasoline, PCBs and DDT, the area of coverage and overall health of the marsh islands of Jamaica Bay has decreased considerably over the last 30+ years (O'Shea and Brosnan, 2000). In particular, a deficit in sediment supply has been implicated as a factor in the dramatic marsh loss in the bay (Hartig et al., 2002).

Natural radionuclides that associate strongly with particles are particularly useful in characterizing particle dynamics in shallow estuarine environments such as Jamaica Bay (see Cochran and Masqué, 2007, for a review). ^{7}Be (half-life = 53 d) and ^{234}Th (half-life = 24.1 d) are short-lived radionuclides that can be used to study seasonal variations in particle transport and deposition, while ^{210}Pb (half-life = 22 .3 y) is useful for studying sediment accumulation and mixing on decadal time scales. Figure 1. shows some of the sources and processes controlling these radionuclides in a tidally-dominated estuary. ^{234}Th and ^{210}Pb are members of the naturally occurring ^{238}U decay series. ^{234}Th is produced in the water column from decay of dissolved ^{238}U, which varies as a function (generally linear) of salinity. Thus, high salinity waters have a higher concentration of ^{238}U and consequently a higher production of ^{234}Th. ^{234}Th that is scavenged, or chemically bound to surface sorption sites on particles in the water column, is said to be present in the sediment in "excess" of its parent ^{238}U activity. The ^{238}U activity of the sediment is effectively equal to the "supported" ^{234}Th activity, i.e. that activity of ^{234}Th that is in radioactive equilibrium with ^{238}U. We are interested in the scavenged portion of the ^{234}Th activity, and in practice, excess ^{234}Th (denoted "$^{234}Th_{xs}$") is determined in sediments by subtracting the measured ^{238}U activity from the measured ^{234}Th activity.

^{210}Pb is introduced to coastal waters principally from the atmosphere, where it is produced by decay of ^{222}Rn that has emanated from terrestrial rocks and soils. In a manner similar to ^{234}Th, ^{210}Pb that has been scavenged from solution onto particles is said to be in "excess" of its parent (actually its grandparent), ^{226}Ra, and excess ^{210}Pb activities are determined in a manner analogous to ^{234}Th. ^{7}Be is also produced in the atmosphere as a consequence of spallation reactions between cosmic rays and atmospheric N_2 and O_2. Once added to coastal waters, ^{7}Be is also particle-reactive and can be scavenged onto sediments. However, unlike ^{234}Th and ^{210}Pb, there is no "supported" or background level of ^{7}Be in sediments, and all the ^{7}Be measured in a sediment sample has been scavenged from solution onto the sediment. The direct supply of both ^{7}Be and ^{210}Pb from the atmosphere varies little spatially over Jamaica Bay, while ^{234}Th production varies in the estuary as a function of salinity.

Because the sources of ^{234}Th, ^{7}Be and ^{210}Pb are relatively well-defined, the radionuclide distributions in estuarine sediments can be examined in the context of a mass balance approach that compares the radionuclide "inventory" in a sediment core with its supply (for example, from production or atmospheric supply to the overlying water column and local scavenging and deposition in bottom sediments). Inventories represent the entire quantity of the radionuclide

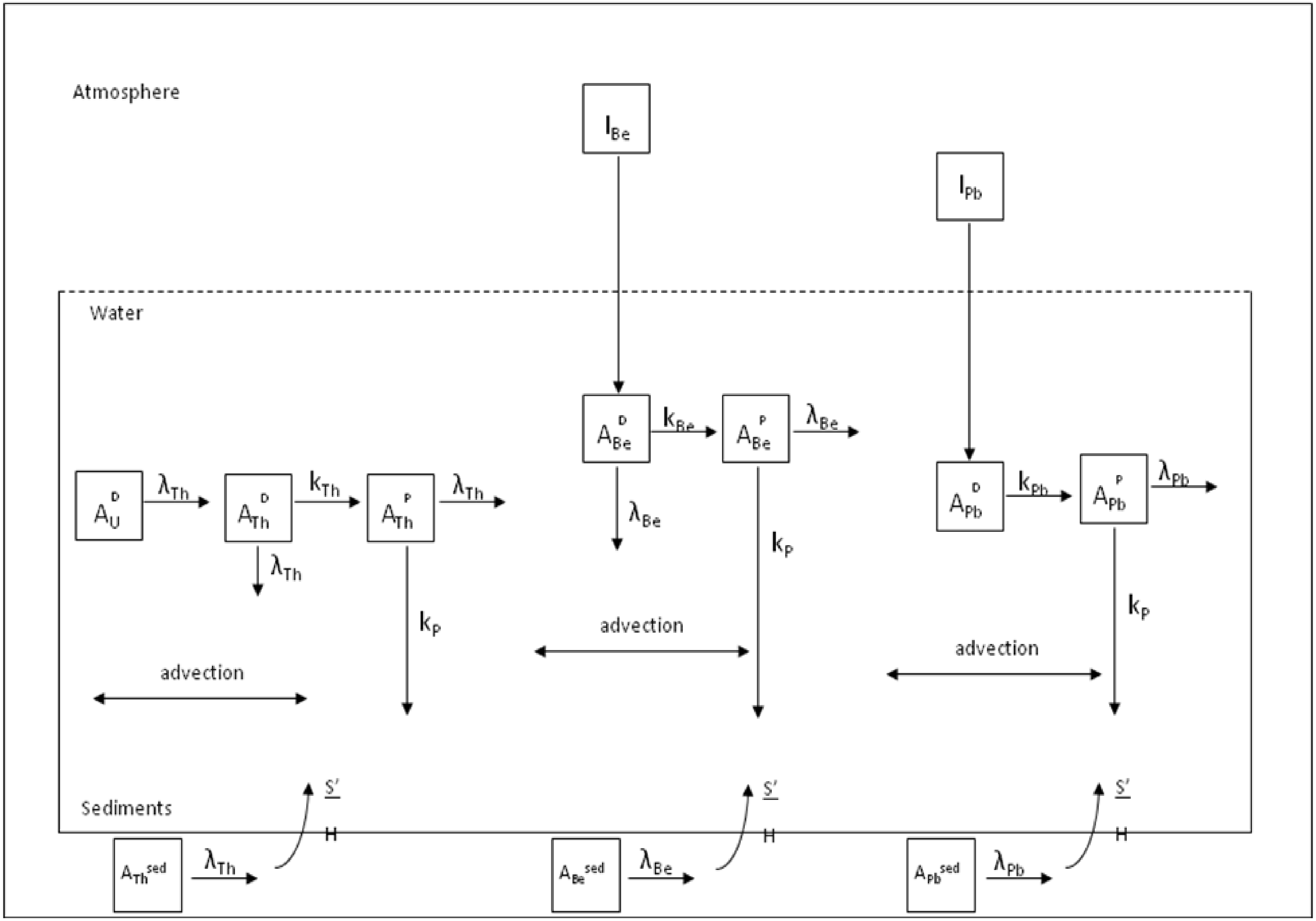


Figure 1. Conceptual model of inputs and cycling of ^{234}Th, ^{7}Be, and ^{210}Pb within an estuarine system. A_U^D represents activity (dpm cm^{-3}) of dissolved ^{238}U, A_{Th}^D, A_{Be}^D, A_{Pb}^D is dissolved ^{234}Th, ^{7}Be, and ^{210}Pb activity (dpm cm^{-3}), A_{Th}^P, A_{Be}^P, A_{Pb}^P represents the particle-associated ^{234}Th, ^{7}Be, and ^{210}Pb activity (dpm cm^{-3}), I_{Be} and I_{Pb} is the flux of ^{7}Be and ^{210}Pb into the estuary from the atmosphere (dpm cm^{-2} day^{-1}), respectively, λ_{Th}, λ_{Be}, and λ_{Pb} represents the decay constants (day^{-1})of the radionuclides, k_{Th}, k_{Be}, and k_{Pb} represents the particle scavenging rate constant (day^{-1}) for each radionuclide, k_P is the particle removal rate constant (day^{-1}), S' represents the particle resuspension rate (g cm^{-2} day^{-1}), h is the water depth (cm), A_{Th}^{sed}, A_{Be}^{sed}, A_{Pb}^{sed} is the activity in the surficial bottom sediments (figure adapted from Feng et al., 1999).

that has been scavenged from the water column and is present in the sediment deposit (expressed in units of dpm cm^{-2}). In practice, inventories can be determined by taking a sediment core, sectioning it with depth, analyzing the excess ^{234}Th, excess ^{210}Pb and ^{7}Be in each section, and then summing the activities. For short-lived ^{234}Th and ^{7}Be, we followed a slightly different approach, collecting a single sample that represented the entire inventory of excess ^{234}Th or ^{7}Be at a site (see *Radionuclides in Subtidal Sediments*). This approach was necessary to complete large scale surveys of the bay (~60 stations) in a short interval of time (compared with the ^{234}Th half-life of 24 d). ^{210}Pb inventories were obtained by sectioning long (gravity) cores taken throughout the Bay.

The determination of radionuclide inventories enables comparison with the theoretical local supply from direct atmospheric deposition (for ^{210}Pb and ^{7}Be) or production from dissolved ^{238}U in the overlying water column (for ^{234}Th). This comparison can show the sediment inventories to be in "surplus" or "deficit" relative to supply. The imbalance implied by surpluses or deficits suggests transport of radionuclide into or out of the area, and, as our data for Jamaica Bay show, suggests additional sources of all the radionuclides considered to the system.

Our goals in this project thus have been to: 1) map the distributions of ^{7}Be and ^{234}Th in the surficial subtidal sediments of Jamaica Bay and use mass balances for these radionuclides to discern temporal patterns of sediment transport and deposition, 2) measure down-core distributions of ^{210}Pb and ^{137}Cs in gravity cores to obtain long-term accumulation rates in the bay, 3) consider radionuclide activities in sediments of salt marshes in the context of particle accumulation in the marshes, and 4) link the radionuclide data on sediment dynamics to the issue of marsh loss in the bay.

Methods

Study Site

Jamaica Bay (Figure 2.) is a small coastal lagoon (53 km^2; Benotti, et al., 2007) located along the southern coast of western Long Island (O'Shea and Brosnan, 2000). The bay is shallow (mean depth ~5 m), has no significant riverine input, and contains numerous salt marsh islands. Ocean water enters the bay through Rockaway Inlet, which serves as a pathway for particle and water exchange between the Bay and the New York Bight. The dominant supply of freshwater is wastewater from three sewage treatment facilities in New York City. The sewer system of New York City is such as to allow for bypassing of wastewater treatment facilities during times of high rainfall. At such times, storm water (and associated ^{210}Pb and ^{7}Be) and wastewater enter the estuary simultaneously. The combined sewer overflow pipes are located throughout the bay (Figure 3.). Combined sewer overflow (CSOs) events that occur after heavy rainfalls may be an important input of freshwater, as well as nutrients, into the bay (Botton et al., 2006; O'Shea and Brosnan, 2000). Due to its location, Jamaica Bay has been subjected to many of the impacts that come with heavy urbanization, such as extensive dredging, marsh ditching, marsh filling, bulkheading, and landfill construction (Botton et al., 2006). The benthic morphology of the lagoon, in particular, has changed substantially over time due to dredging activities.

Field Methods

Subtidal sediment samples were collected in Jamaica Bay during cruises in September-2004, May-2005, November-2005, and July-2006. The sample sites were distributed throughout the bay, and an effort was made to sample the full range of sediment types (see section 3.1 below) and water depths. As data from the initial sampling in September-2004 became available, future sampling campaigns were adjusted to emphasize regions of interest (e.g. muddy areas, those with high radionuclide inventories or near CSO outfalls). Generally stations were re-occupied during the May and November-2005 and July-2006 cruises, but logistical constraints (weather, state-of-tide, etc.) made it not possible to sample exactly the same complement of stations each time.

Surficial sediment samples used for $^{234}Th_{xs}$ inventories and ^{210}Pb activities were collected using an Ekman bottom grab. Each grab sample was examined to insure the sediment surface was preserved and then the top 5 cm of the grab sample were sub-sampled and returned to the lab for radiometric analysis. This sampling strategy was designed to obtain the entire sediment inventory of ^{234}Th and ^{7}Be in a single sample at each site and thus maximize the number of sites sampled at any given time. Generally, 60-70 sites were sampled each time and initial gamma counting was completed within ~3 weeks. This intensity of sampling, plus the fact that all sediment provinces were sampled in the bay on each cruise, makes it possible to make meaningful temporal comparisons of bay-wide radionuclide distributions.

Sediment samples also were collected on selected marsh islands in September-2004 and May-2005 at the same times as the subtidal sampling. Samples were taken by inserting a ~5 cm core tube into the marsh peat. In the laboratory, the sample was extruded, homogenized and counted by gamma spectrometry in the same way as the subtidal samples (see section 2.2). In September-2004, 24 surficial sediment samples were taken on Duck Point, Ruffle Bar, Little Egg, JoCo, and

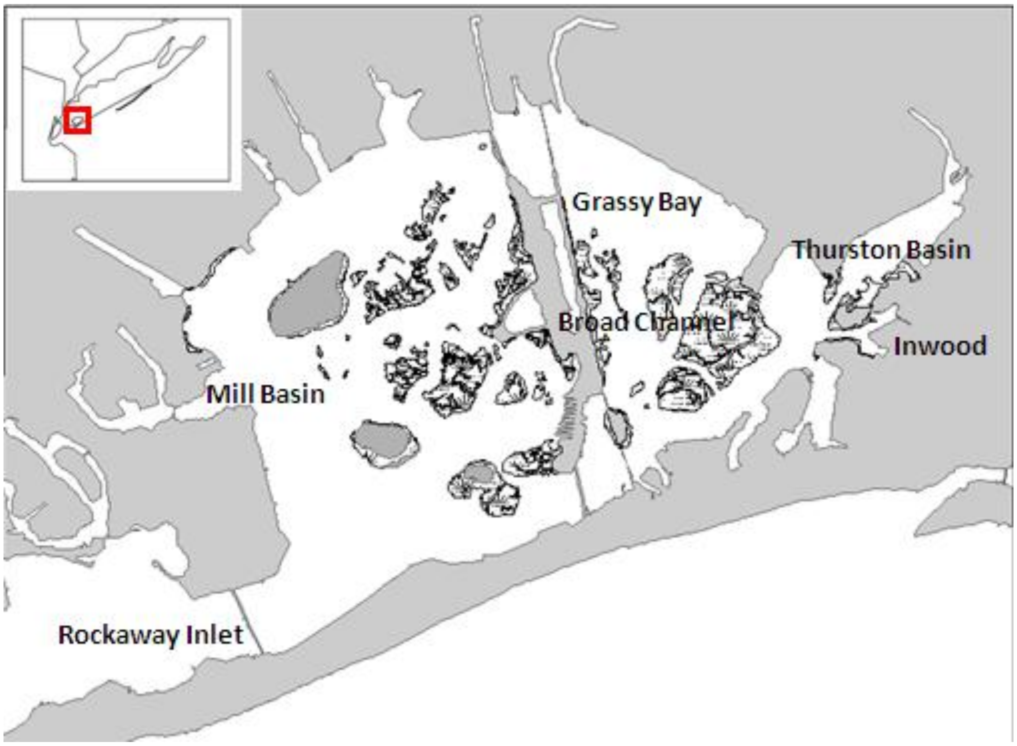


Figure 2. Jamaica Bay location map

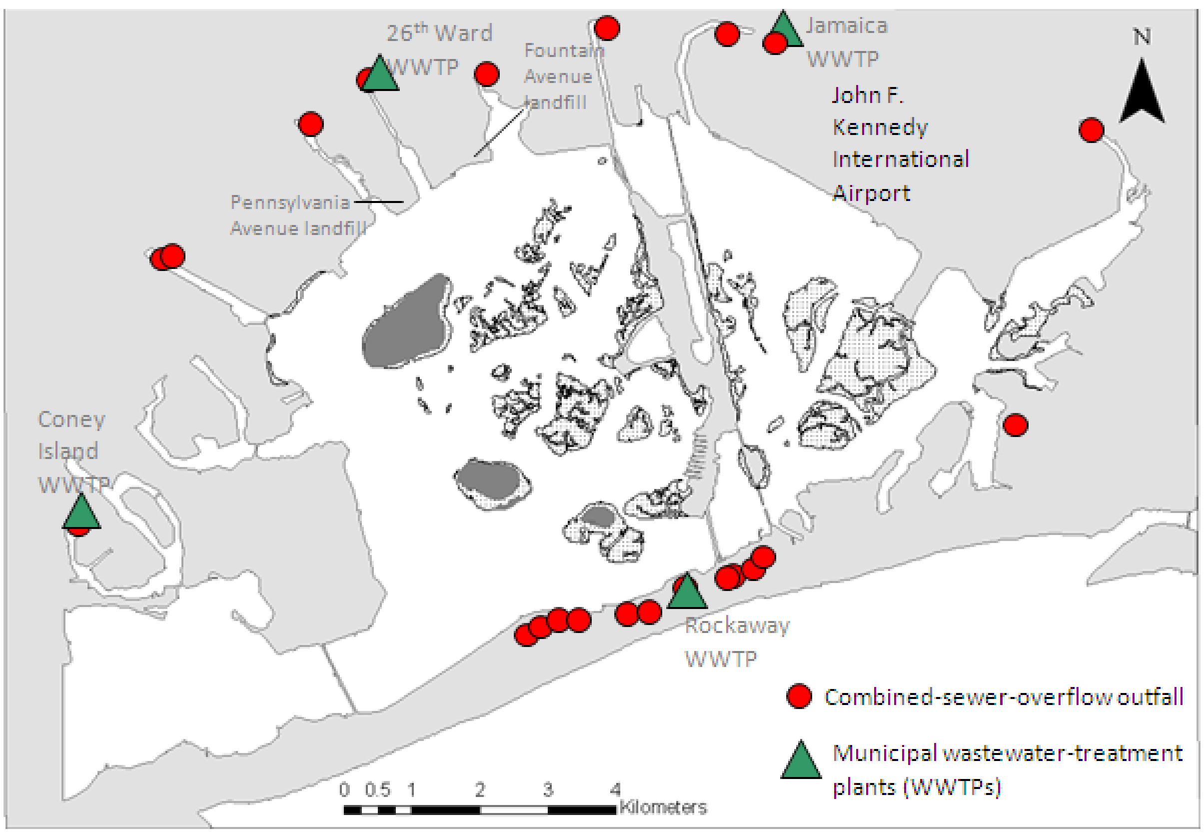


Figure 3. Location map of wastewater treatment plants and combined-sewage overflow outfall (adapted from Benotti et al., 2007).

East High marshes (Figure 4.). In May-2005, 29 marsh samples were taken on the marsh islands of Elders Point, Yellow Bar, Little Egg, Big Egg, JoCo, and East High (Figure 4.). In part, the sites were selected to follow up on previous sampling (long cores for ^{210}Pb) at three of the sites (Big Egg, East High and JoCo) by Kolker (2005). Sampling in the marshes was determined by accessibility and state of the tide. Thus it was not possible to sample all sites in both Septermber-2004 and May-2005. However, JoCo and East High marshes were sampled at both times.

Long-term sediment accumulation rates in the bay were determined using $^{210}Pb_{xs}$ profiles in gravity cores (> 30 cm) that were taken at 8 locations in the bay (Figure 5.). Cores were then returned to the lab for radiometric analysis

The activities of ^{234}Th and ^{210}Pb associated with particles in the water column entering the bay and within the bay were measured by filtering large volumes (>100 liters) of bay water through ship-powered in-situ pumps equipped with a polypropylene filter cartridge (CUNO Micro-Wynd II® D-CCPY, nominal 1 μm) at select sites (Figure 6.). 2-L water samples were also taken at these sites to determine total ^{234}Th (particles + dissolved) in the water column.

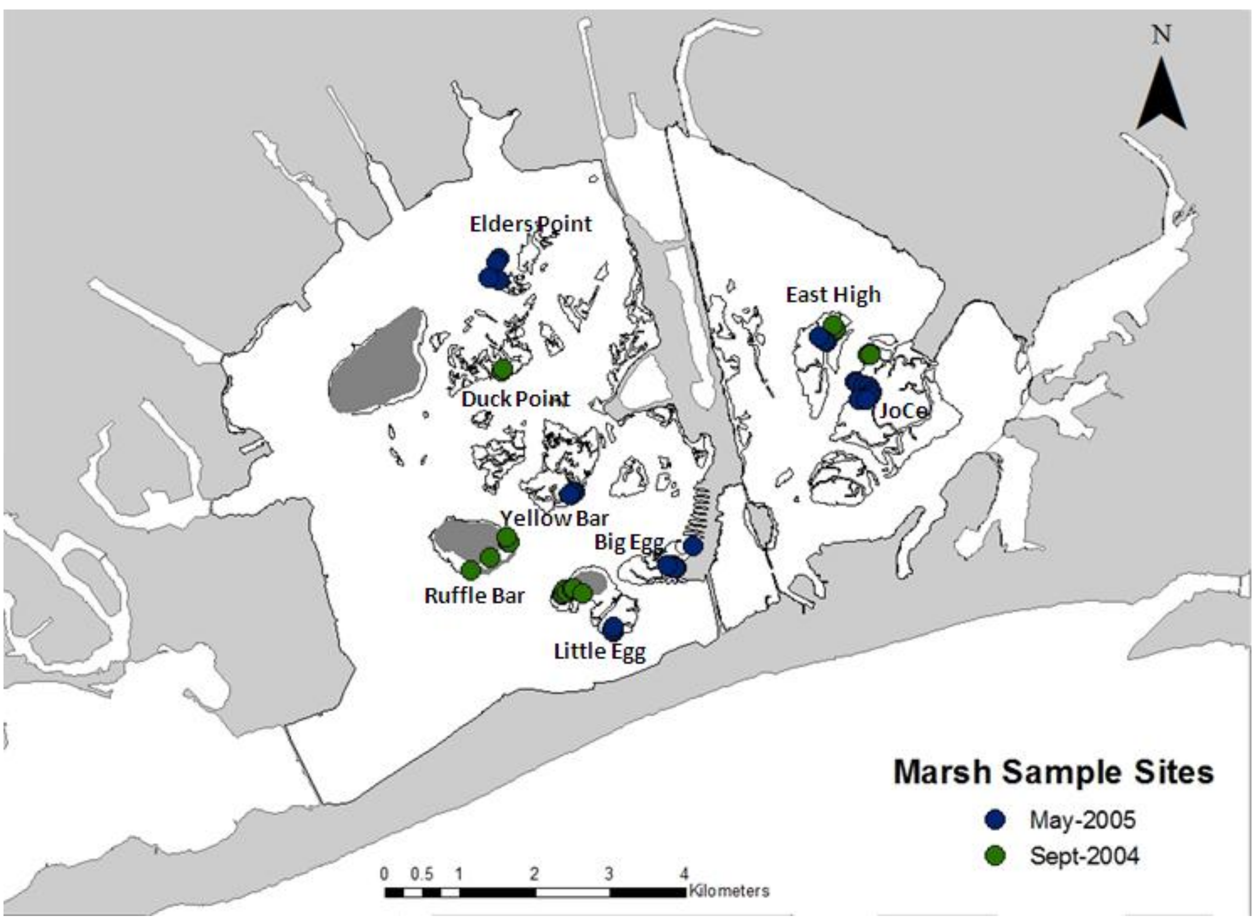


Figure 4. Marsh sampling sites in September-2004 and May-2005.

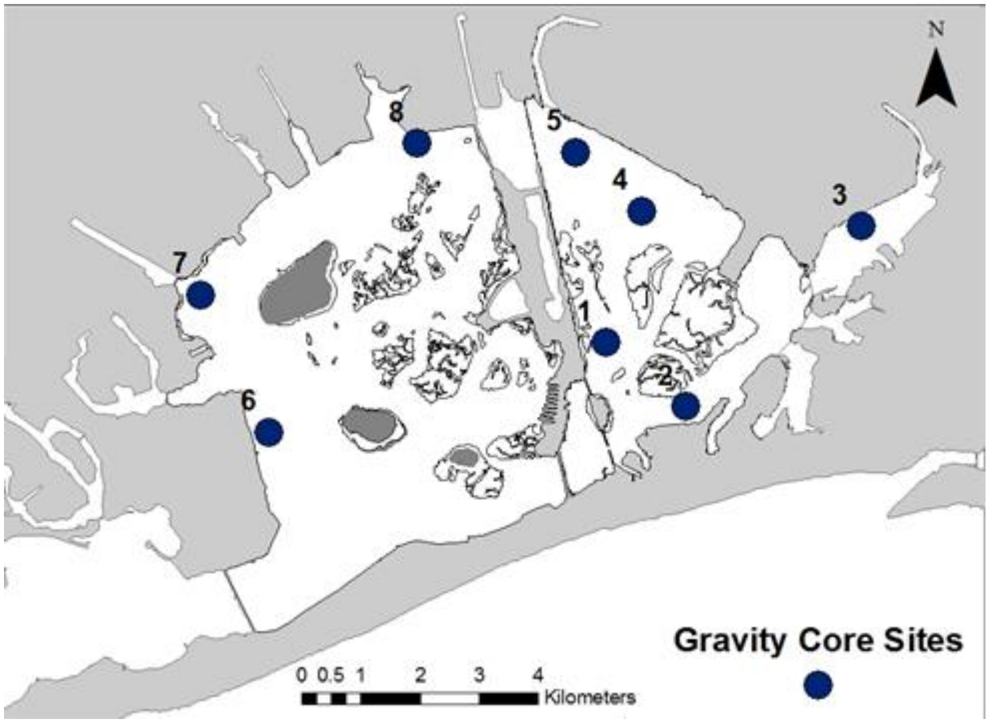


Figure 5. Gravity core location site map

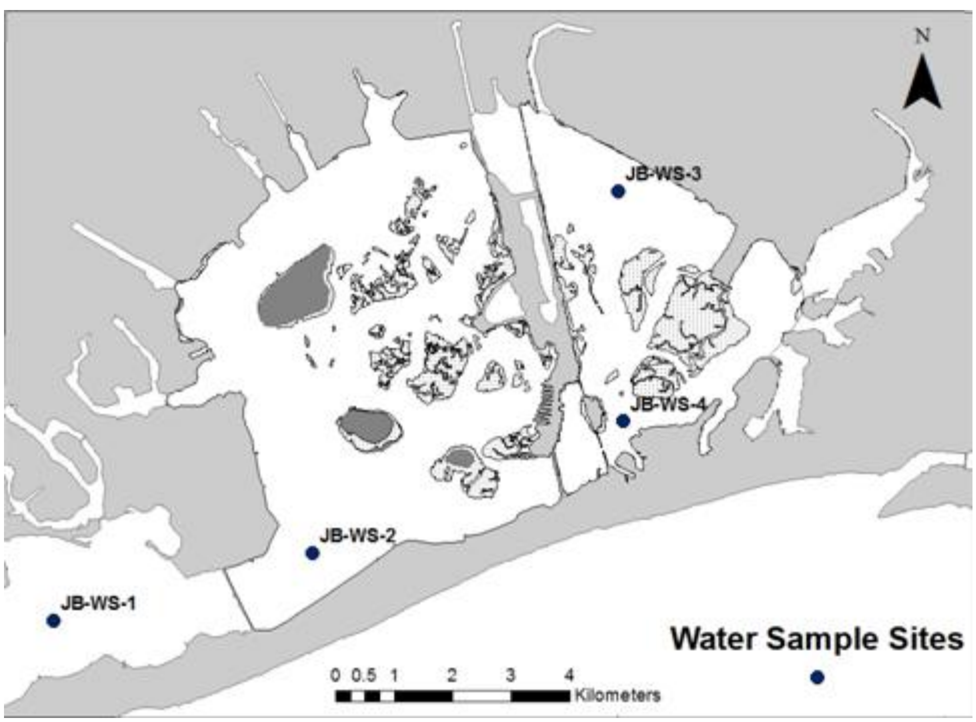


Figure 6. Water column sampling sites (for collection of filterable particles)

Laboratory Methods

The surficial sediment samples were returned to the lab, homogenized, and weighed. Samples were analyzed for ^{210}Pb (46 keV), ^{234}Th (63 keV), ^{214}Pb (352 keV) and ^{7}Be (477 keV) by counting the wet samples on a Canberra 3800 mm^2 germanium gamma detector for ~ 24 hours. To determine counting efficiencies and to correct for the self-absorption that occurs below 200 keV, liquid standards of varying densities were spiked with ^{238}U and ^{226}Ra and counted several times on each detector. Supported ^{210}Pb (that portion of the ^{210}Pb activity in radioactive equilibrium with ^{226}Ra) was determined by measuring the ^{214}Pb (granddaughter of ^{226}Ra) activity of the sample. This activity was then subtracted from the total ^{210}Pb activity to determine excess ^{210}Pb (denoted $^{210}Pb_{xs}$) activity in each sample. For ^{234}Th, sediment samples were recounted after 4 months to determine the ^{234}Th supported by the decay of ^{238}U within the samples; this value was subtracted from the measured total ^{234}Th to determine excess ^{234}Th (denoted $^{234}Th_{xs}$) activities. Both excess ^{234}Th and ^{7}Be were corrected for radioactive decay from the time of counting to core collection.

A subsample was then combusted in a furnace at 450°C for >6 hours to determine loss on ignition (LOI), a proxy for organic content. The remainder of the dried sample was soaked in a 0.5% sodium hexametaphosphate solution, agitated, and then wet sieved through a 63 micron sieve to determine the percentages of the mud and sand fractions.

Gravity cores were returned to the lab and immediately frozen. Later the cores were extruded and sectioned. The upper 20 cm were sectioned into 2-cm intervals, from 20 cm to 48 cm the cores was sectioned into 4-cm intervals, and the remainder of the core was sectioned into 8-cm intervals. Each interval was counted wet on a Canberra 3800 mm^2 germanium gamma detector for ~ 24 hours to determine ^{210}Pb, ^{214}Pb, and ^{137}Cs activities. ^{210}Pb supported by the in situ decay of ^{226}Ra was determined from the ^{214}Pb activity in each interval. The excess ^{210}Pb ($^{210}Pb_{xs}$) activity of each core interval was then determined by subtracting the supported activity from the total activity. The samples were then dried in an oven overnight at 60°C. A subsection of the sample was combusted in a furnace at 450° for >6 hours to determine LOI.

Cartridges containing particles from the high-volume water column sampling were ashed in a furnace at 450°C for 8 hours, and the ash was counted on a Canberra 3800 mm^2 germanium gamma detector for 24 hours to determine activities of ^{210}Pb, ^{234}Th and ^{7}Be on filterable particles.

Total ^{234}Th was determined using a small volume co-precipitation with MnO_2 (Rutgers van der Loeff et al., 2006). The precipitate was filtered through a 25mm diameter 1 micron filter, mounted, and counted on a Risø Beta Multicounter System. Samples were counted 4 times to follow the decay of ^{234}Th and differentiate beta emissions from ^{234}Th from other beta emitters.

Results

Sediment Organic Content and Grain Size

A compilation of wet sieve results and LOI results for the subtidal, bottom samples from the four sampling cruises was used to create the contour map shown in Figures 7. and 8. Fine-grained sediments dominated the eastern part of the bay, in particular Grassy Bay, but coarser sediments were found in the western bay adjacent to the marsh islands. Fine-grained sediments also dominated in the northwestern channel of the bay near the combined sewage overall outfalls. LOI results show a similar distribution where high LOI (indicating high organic content) was found in the eastern part of the bay and low LOI was measured in the western bay near the marsh islands.

Radionuclides in Subtidal Sediments

Inventories of $^{234}Th_{xs}$ in sediments were calculated using the equation:

$$I_{Th} = A_{Th} \times \rho_i \times 5\ \mathrm{cm} \qquad (1)$$

where I_{Th} is the $^{234}Th_{xs}$ inventory (dpm cm^{-2}), A_{Th} is the $^{234}Th_{xs}$ activity (dpm g^{-1}) of $^{234}Th_{xs}$, ρ_i is the dry bulk density of the sample (g cm^{-3}), and 5 cm is the depth of each sample. As noted above, the sampling scheme was designed to obtain the entire excess ^{234}Th inventory in a single sample. This procedure was checked through subsampling a few cores and found to be valid. ^{7}Be inventories were calculated in a similar manner.

Inventories of ^{210}Pb were determined on sectioned gravity cores using:

$$I_{Pb} = \sum_i (A_i\, \rho_i\, x_i) \qquad (2)$$

where I_{Pb} is the inventory of excess ^{210}Pb within the core (dpm cm^{-2}), A_i is the ^{210}Pb activity (dpm g^{-1}) of the i^{th} interval of the core, ρ_i is the bulk density of that interval, and x_i is the thickness of the interval.

The results show that there were significant spatial and seasonal variations in the inventories of $^{234}Th_{xs}$ and surficial ^{210}Pb activities within Jamaica Bay during the sampling cruises (Figures 9. and 10.). ^{7}Be results for the subtidal sediments are given in Appendix A. The range of inventories and activities of $^{234}Th_{xs}$ and $^{210}Pb_{xs}$ measured during four sampling cruises in 2004-2006 and the bay-wide means of activities and inventories of the radioisotopes are given in Table 1. The production of ^{234}Th in the water column from the decay of ^{238}U can be estimated using the conservative relationship found between ^{238}U and salinity, ^{238}U (dpm L^{-1}) = 0.0707 × salinity + 0.0276 (Feng et al., 1999; Rutgers van der Loeff et al., 2006). Using a mean depth of 5 meters (Benotti et al., 2007) and an upper limit on the bay salinity (32 psu), ^{234}Th production in the water column from the decay of ^{238}U is estimated to be a maximum of ~1.2 dpm cm^{-2}. The mean $^{234}Th_{xs}$ inventories in the surficial bottom sediments ranged from 3.4 – 5.6 dpm cm^{-2}, and these values are approximately 3-5x the expected production of ^{234}Th from the decay of ^{238}U within the bay (Table 1).

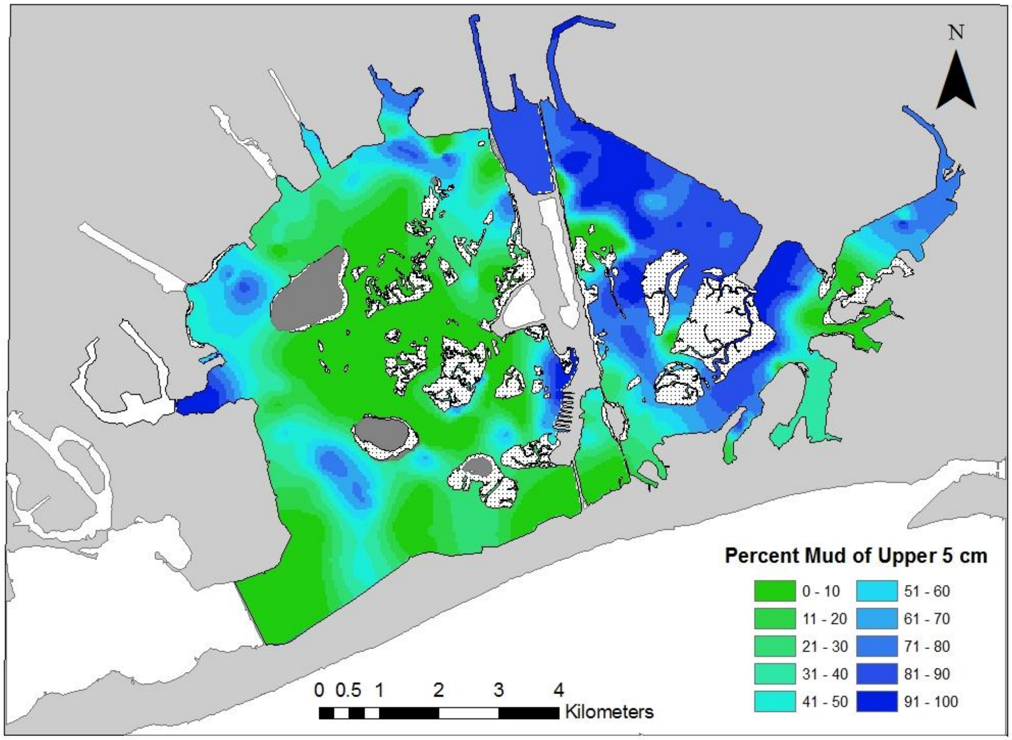


Figure 7. Mud content of the surficial, subtidal sediments of Jamaica Bay.

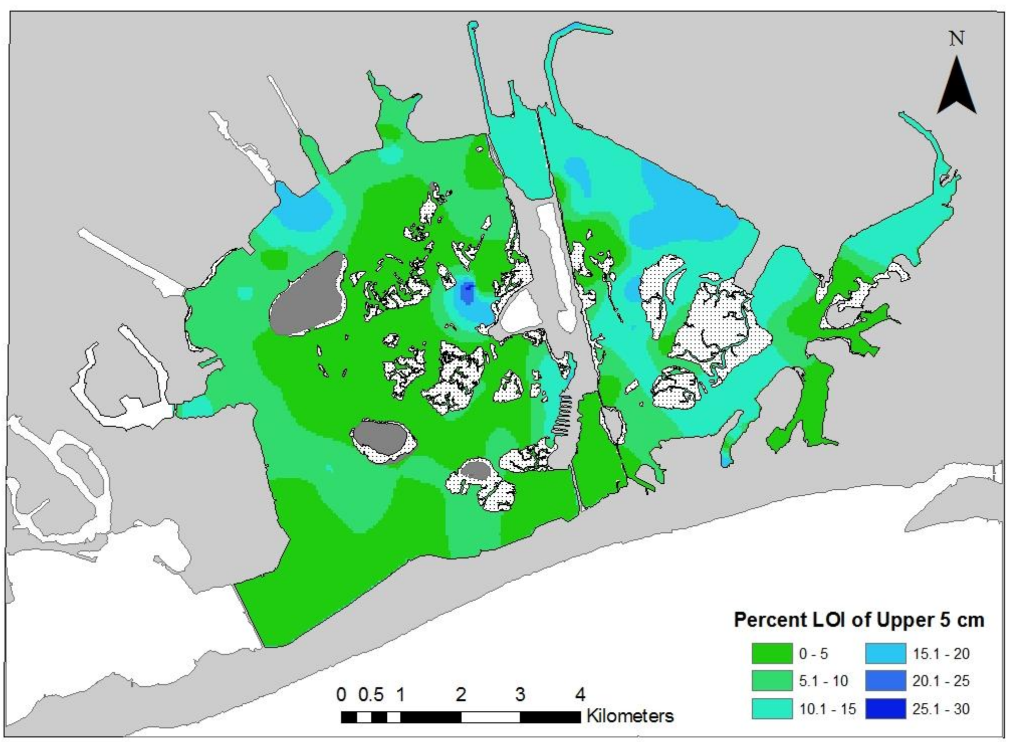


Figure 8. Organic content (as loss-on-ignition, LOI) of the surficial, subtidal sediments of Jamaica Bay

General Patterns of Radionuclides in Subtidal Sediments

The spatial and seasonal variation of $^{234}Th_{xs}$ in the bottom sediments during the sampling cruises are shown in Figure 9. In September-2004 the highest inventories of $^{234}Th_{xs}$ were measured near the marsh islands in the western part of the bay and in the southern channel adjacent to the Rockaway wastewater treatment plant and combined-sewer overflow outfall (Figure 10.A). High inventories also were observed in the southeastern part of the bay (Figure 9.A). Inventories

of $^{234}Th_{xs}$ from the May-2005 cruise were also high near the marsh islands in the western portion of the bay, however there were also high inventories near the inlet (Figure 9.B). In November-2005 high inventories were measured throughout the bay with the highest $^{234}Th_{xs}$ inventories in the eastern part of the bay, particularly near the marsh islands, and in the southeastern deep channel (Figure 9.C). During the July-2006 sampling cruise, the $^{234}Th_{xs}$ inventory pattern was similar to November-2005 with highest $^{234}Th_{xs}$ in the bottom sediment near the eastern marshes and in the southeastern channel (Figure 9.D).

Spatial distribution of $^{210}Pb_{xs}$ activity in the surficial bottom sediments of Jamaica Bay had a different pattern than the short-lived $^{234}Th_{xs}$ inventories. During all the sampling cruises high $^{210}Pb_{xs}$ activities were measured in the eastern part of the bay, as well as, in the northwestern part of the bay near a combined-sewer overflow outfall (Figures 3 and 10).

Inventories of ^{7}Be in the subtidal sediments are given in Appendix A. They show patterns similar to those of $^{234}Th_{xs}$, but high inventories of this radionuclide are evident in sediments off the CSO outfalls in the northwestern part of the bay.

Activities of ^{234}Th and ^{210}Pb on Suspended Particles

A summary of the activity of ^{234}Th and ^{210}Pb on suspended particles and total ^{234}Th in the water column can be seen in Table 2. The highest excess ^{234}Th particulate activities were measured at the station closest to the inlet and in deep water just within the inlet (Table 2). At the interior stations, away from the inlet, the ^{234}Th activity on particles decreased. $^{210}Pb_{xs}$ activities on particles in the water column were highest at the inlet and decreased in the interior of the lagoon. Total ^{234}Th (dissolved + particulates) was highest at the inlet station.

Radionuclide Activities and Inventories in Salt Marshes

Select marsh islands of Jamaica Bay were sampled in September-2004 and May-2005 (Figure 4.). Mean $^{234}Th_{xs}$ and ^{7}Be inventories and $^{210}Pb_{xs}$ activities on marsh islands sampled in September-2004 and May-2005 are shown in Tables 3-5. Mean $^{234}Th_{xs}$ inventories on the marsh islands were higher in September-2004 than May-2005, while mean $^{210}Pb_{xs}$ activities were similar between sampling periods. The mean $^{234}Th_{xs}$ inventories on the marsh islands during both sampling periods generally showed a surplus relative to the inventory expected from ^{234}Th production by the decay of ^{238}U in the subtidal bay (~1.2 dpm cm^{-2}, see section 3.1; Tables 3 - 5). The same sites were not sampled in both September-2004 and May-2005; however, there still appears to be a general trend in which marshes in the western bay had higher $^{234}Th_{xs}$ inventories than the eastern marshes (Table 3).

In September-2004, Duck Point marsh had the highest mean $^{234}Th_{xs}$ inventory, while JoCo marsh had the lowest mean inventory (Table 4, Figure 11.). The mean activity of $^{210}Pb_{xs}$ in the surficial marsh sediments had the highest activity in JoCo marsh. Sample location sites for May-2005 are shown in Figure 12. $^{234}Th_{xs}$ inventories were highest at Yellow Bar marsh and lowest at East High marsh in the east and Elders Point marsh in the west, where no $^{234}Th_{xs}$ was measured (Table 5). The mean ^{210}Pb activity was highest at Big Egg marsh in September-2004.

Decadal-scale Sediment Accumulation Rates

Eight gravity cores were taken in Jamaica Bay in areas dominated by fine-grained sediments and analyzed for ^{210}Pb, ^{214}Pb and ^{137}Cs to determine the longer-term accumulation trends. Plots of excess ^{210}Pb activity versus depth in each of the gravity cores are shown in Figure 13. Inventories of $^{210}Pb_{xs}$ were calculated for all cores (eqn. 2) to aid in assessing ^{210}Pb sources, as well as active sediment deposition or removal within the estuary. The $^{210}Pb_{xs}$ inventories of the cores collected in the bay ranged from 167 to 351 dpm cm^{-2} (Table 6).

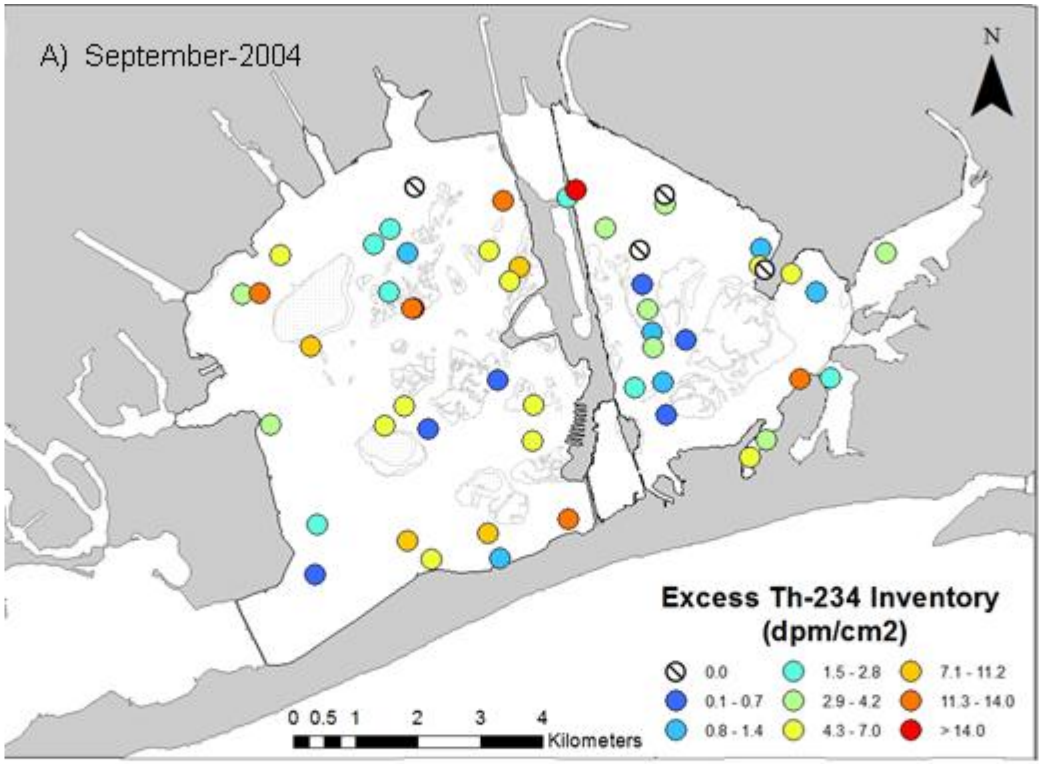
Sediment accumulation rates were calculated using a "constant initial activity" which assumes that initial $^{210}Pb_{xs}$ activity in the sediments has been constant with time. The change of $^{210}Pb_{xs}$ activity with depth is then described by the following equation

$$A = A_0 \exp(-\lambda\, x/S) \qquad (3)$$

where A is the $^{210}Pb_{xs}$ activity at depth, A_0 is the initial activity (at x = 0), λ is the decay constant of ^{210}Pb, x is depth in the core (cm), and S is the sediment accumulation rate (cm yr^{-1}). The accumulation rate is then determined by best fit line through a plot of ln A vs. x. This model can be affected by the compositional changes that change the initial activity and thus provide only an average accumulation rate. In addition, bioturbation can alter the ^{210}Pb gradient with depth in a core, such that the sediment accumulation rate obtained from eqn (3) is a maximum. Bioturbation is minimal in certain areas of Jamaica Bay (e.g. Grassy Bay) due to hypoxic bottom water, but in general can not be discounted as a factor affecting the ^{210}Pb profiles. Thus we consider the rates presented in Table 6 to be upper limits on the true long-term sediment accumulation rate

The sediment accumulation rates obtained from ^{210}Pb can be checked for consistency by analysis of the ^{137}Cs profile in the core. In five of the cores, a clear ^{137}Cs peak was detected. The value of S may be estimated by assuming that this peak corresponds to the 1963 maximum in global ^{137}Cs fallout. In cores 2, 3, and 6 the depth of the 1963 peak was not reached, and therefore, estimates of S can not be made using ^{137}Cs. The accumulation rates estimated by $^{210}Pb_{xs}$ and ^{137}Cs for the cores taken within the bay are compiled in Table 6.

Accumulation rates of the bay from the gravity cores ranged from 1.1 to 0.1 cm yr^{-1}. High accumulation rates were found in the western part of the bay, near a CSO outfall. In Grassy Bay, in the northeastern part of Jamaica Bay, accumulation rates at two sites were 0.79 to 1.04 cm yr^{-1}. These rates are consistent with previous work in this area which indicated a sediment accumulation rate of 0.92 cm yr^{-1} (Ferguson et al., 2003). The lowest accumulation rate measured was in core 3, located in the northeastern part of the bay in the Thurston Basin. Mass accumulation rates determined from the $^{210}Pb_{xs}$ profiles range from 0.01 to 0.89 g cm^{-2} y^{-1}; Table 6).



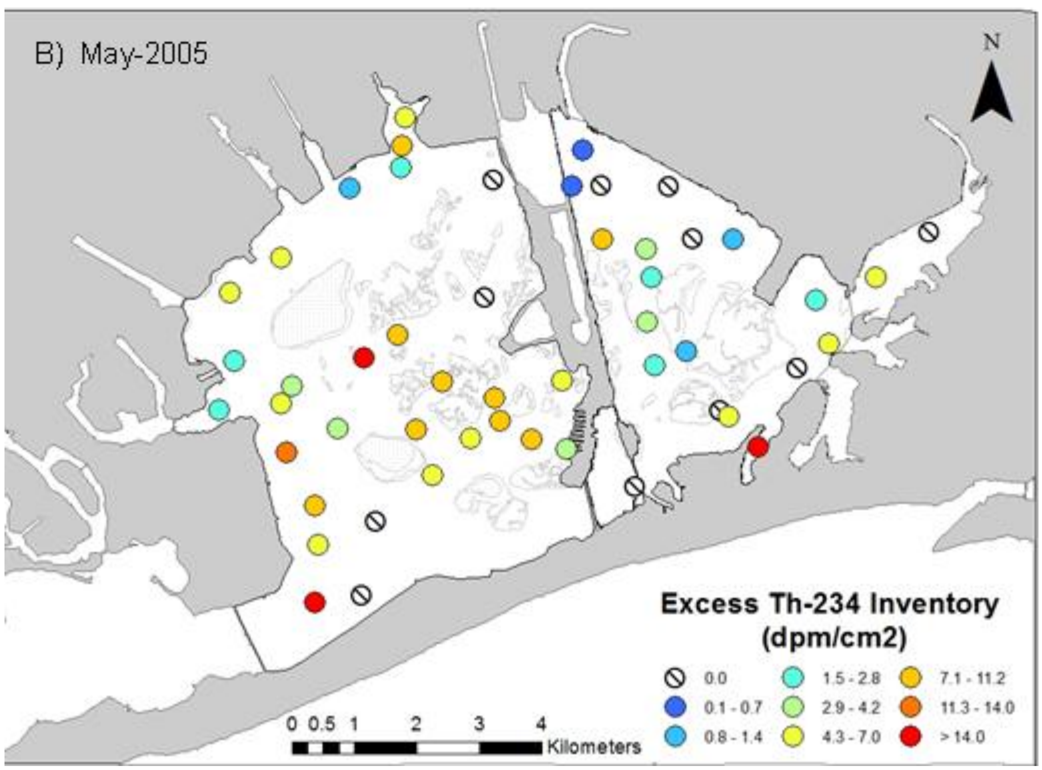


Figure 9. $^{234}Th_{xs}$ Inventory of surficial bottom sediments during A) September-2004, B) May-2005, C) November-2005 and D) July-2006 cruises.

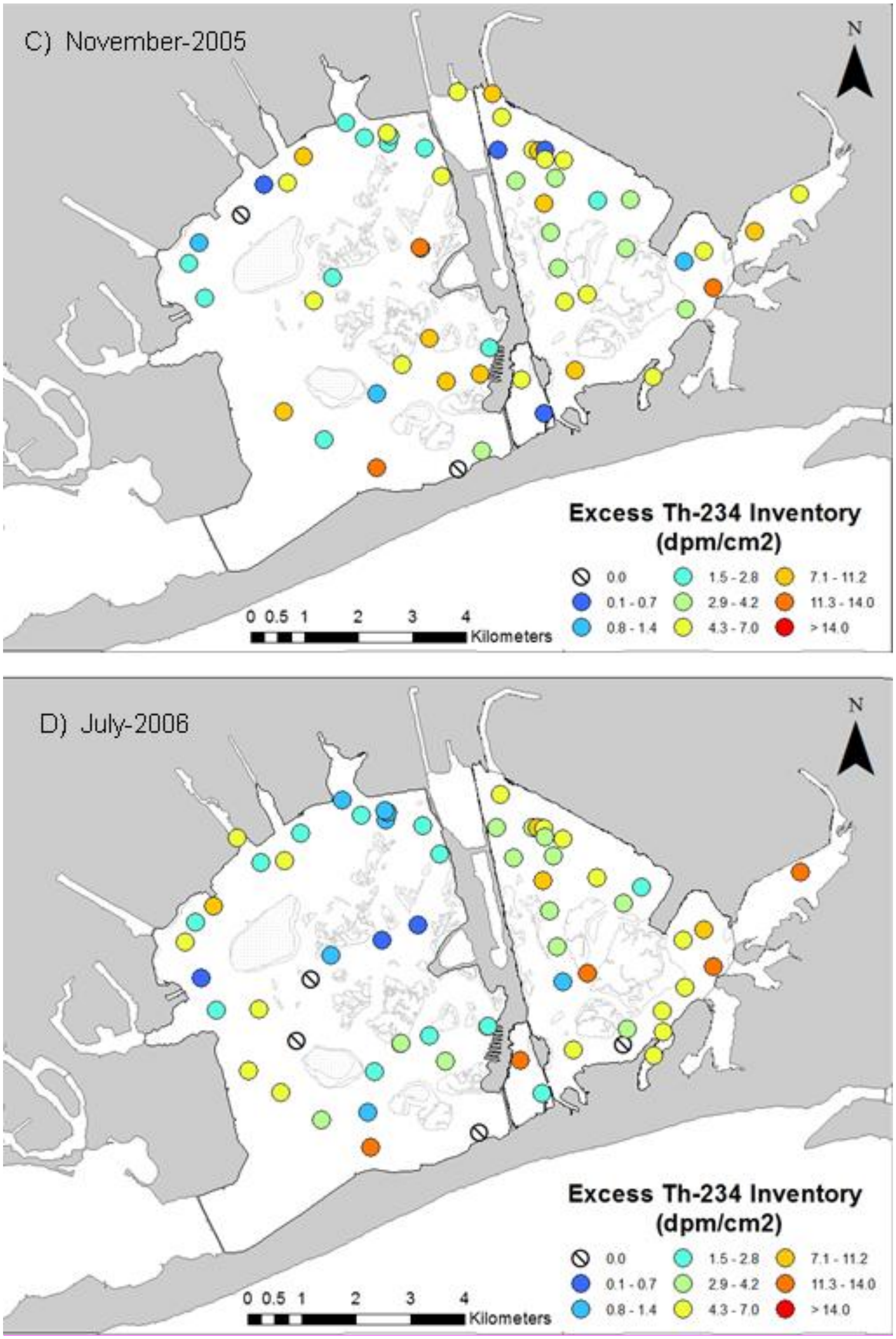


Figure 9. Continued.

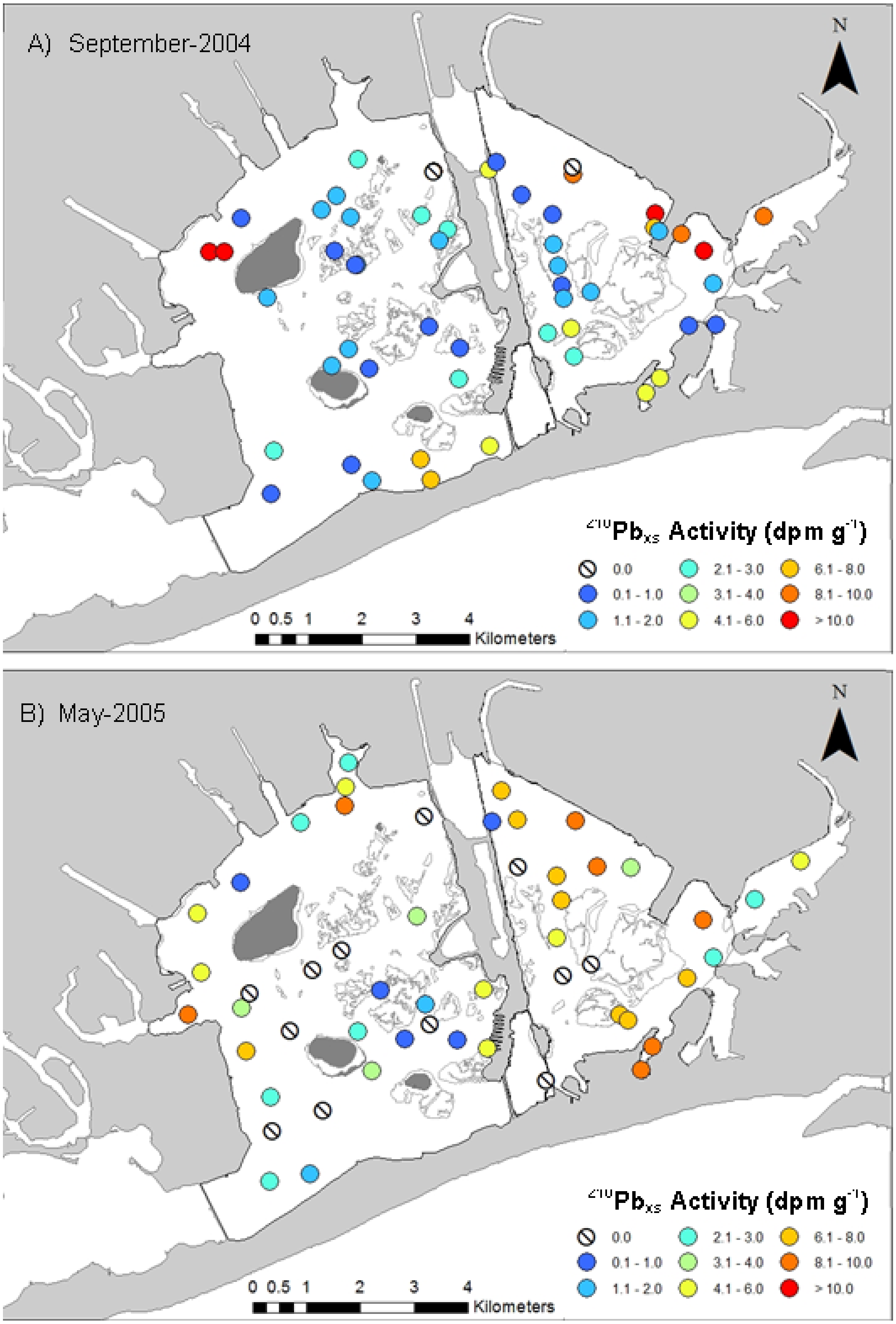
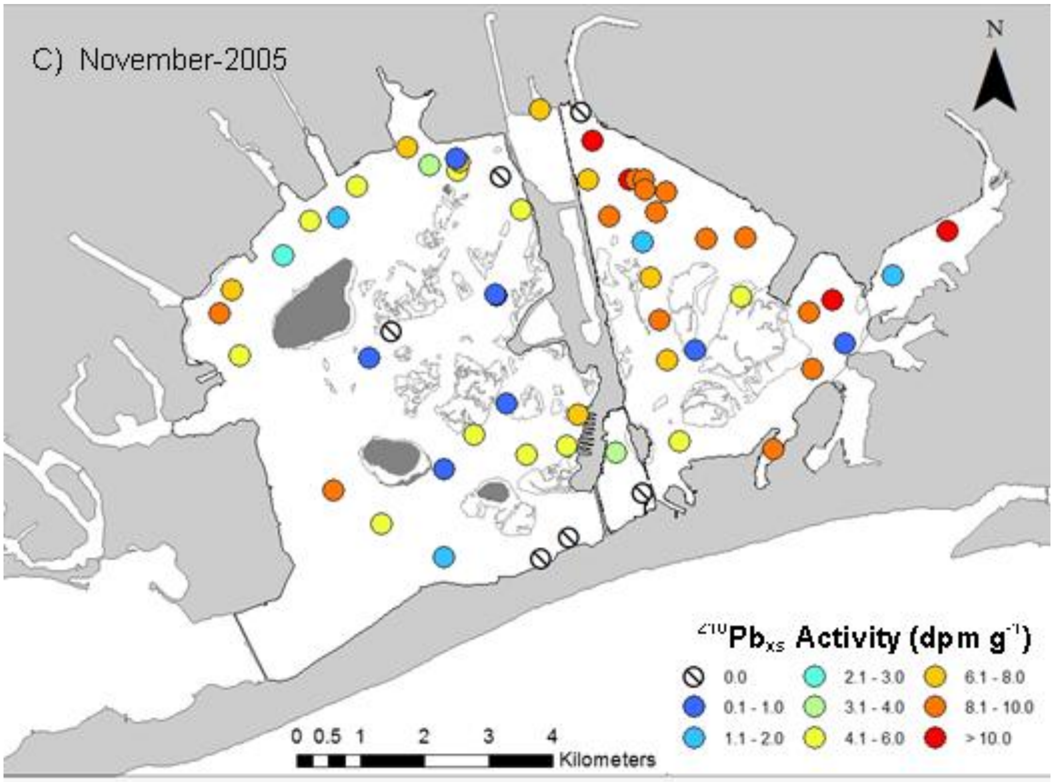


Figure 10. Excess ^{210}Pb activity (dpm g^{-1}) in the upper 5 cm of the bottom sediment during A) September-2004, B) May-2005, C) November-2005 and D) July-2006 sampling cruises.



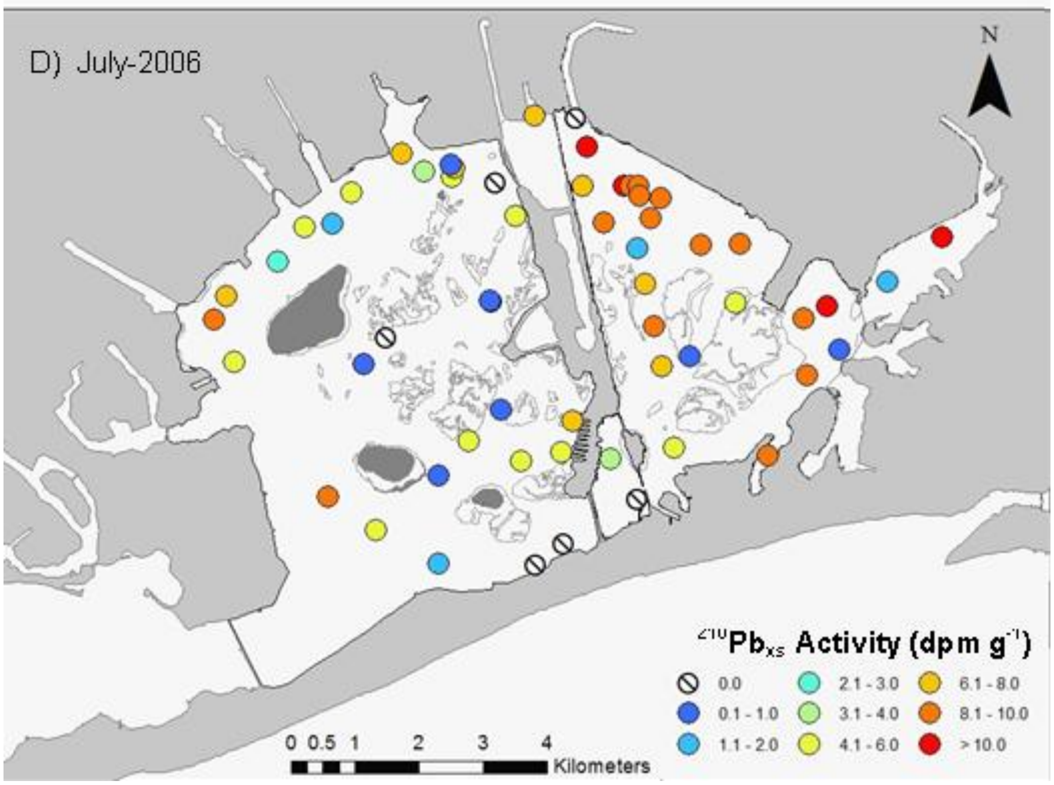


Figure 10. Continued.

Table 1. Summary table of radionuclide data from September-2004, May-2005, November-2005, and July-2006 sampling cruises

	Mean $^{234}Th_{xs}$ Activity (dpm g^{-1})	Mean $^{234}Th_{xs}$ Inventory (dpm cm^{-2})	$^{234}Th_{xs}$ inventory /Mean Production*	Mean ^{210}Pb Activity (dpm g^{-1})
September-04	1.4 ± 0.2	5.6 ± 0.8	4.7	3.5 ± 0.5
May-05	1.5 ± 0.6	3.4 ± 0.7	2.8	3.2 ± 0.4
November-05	1.8 ± 0.2	4.5 ± 0.4	3.8	3.5 ± 0.4
July-06	1.8 ± 0.2	3.6 ± 0.4	3.0	4.7 ± 0.4

* Relative to upper limit on mean production of ^{234}Th in subtidal bay, 1.2 dpm cm^{-2} (see text for discussion)

Table 2. ^{234}Th, ^{7}Be, ^{210}Pb activities of filterable (< 1 □m) particles in the water column

Sample ID	Description	Depth (m)	Salinity	TSS (mg L^{-1})	^{234}Th$_{xs}$ (dpm g^{-1})	^{234}Th$_{xs}$ (dpm L^{-1})	Total ^{234}Th (dpm L^{-1})*	^{210}Pb$_{xs}$ (dpm g^{-1})
JB-WS-1	Inlet Station	3.0	28.5	13.5	14.8 ± 1.0	0.3 ± 0.02	0.5 ± 0.1	10.9 ± 1.1
JB-WS-2-Shallow	Bay Interior	1.0	28.3	13.1	4.1 ± 0.5	0.1 ± 0.01	0.2 ± 0.1	1.8 ± 0.3
JB-WS-2-Deep	Bay Interior	5.0	28.5	16.5	5.5 ± 0.6	0.1 ± 0.01	0.2 ± 0.1	2.1 ± 0.4
JB-WS-3	Grassy Bay	5.0	26.6	15.0	3.1 ± 0.5	0.1 ± 0.02	0.1 ± 0.1	0.4 ± 0.2
JB-WS-4	Near eastern marshes	2.0	27.5	15.2	2.2 ± 0.5	0.1 ± 0.02	0.1 ± 0.1	0.7 ± 0.2

*Includes particulate ^{234}Th$_{xs}$ + Dissolved ^{234}Th.

Table 3. Mean $^{234}Th_{xs}$, ^{7}Be inventories and $^{210}Pb_{xs}$ activities in Jamaica Bay marshes during September-2004 and May-2005 samplings

* Mean production of ^{234}Th in the subtidal zone (1.2 dpm cm^{-2}) is used for normalization (see text for discussion).

** Relative to direct atmospheric input of ^{7}Be.

Sample Period		**Mean $^{234}Th_{xs}$ Inventory (dpm cm^{-2})**	**$^{234}Th_{xs}$ inventory /Production***	**Mean ^{7}Be Inventory (dpm cm^{-2})**	**^{7}Be inventory /Input****	**Mean $^{210}Pb_{xs}$ Activity (dpm g^{-1})**
September-2004	Total	5.4 ± 0.9	4.5	2.1 ± 0.26	0.6	4.7 ± 1.1
	West Marshes	6.0 ± 1.3	5.0	1.8 ± 0.3	0.6	2.5 ± 0.6
	East Marshes	4.1 ± 1.2	3.4	2.7 ± 0.7	0.8	6.5 ± 1.6
May-2005	Total	2.7 ± 1.0	3.2	1.7 ± 0.5	1.1	3.1 ± 0.8
	West Marshes	3.4 ± 1.3	3.8	1.4 ± 0.4	0.9	2.8 ± 1.2
	East Marshes	1.8 ± 1.7	1.8	2.1 ± 1.1	1.3	3.2 ± 1.0

Table 4. Mean $^{234}Th_{xs}$ inventory, ^{7}Be inventory, and $^{210}Pb_{xs}$ activity in the surficial sediments on Jamaica Bay marsh islands in September-2004

* Mean production of ^{234}Th in the subtidal zone (1.2 dpm cm^{-2}) is used for normalization (see text for discussion).

** Relative to direct atmospheric input of ^{7}Be.

Marsh Island	Mean $^{234}Th_{xs}$ Inventory (dpm cm^{-2})	$^{234}Th_{xs}$ inventory /Production *	Mean ^{7}Be Inventory (dpm cm^{-2})	^{7}Be inventory /Input**	Mean $^{210}Pb_{xs}$ Activity (dpm g^{-1})
Duck Point	6.9 ± 4.8	5.8	2.4 ± 1.5	0.7	2.5 ± 0.17
Ruffle Bar	6.1 ± 1.3	5.1	2.6 ± 0.5	0.8	4.6 ± 1.6
Little Egg	5.6 ± 1.9	4.7	1.1 ± 0.25	0.3	1.2 ± 0.2
East High	4.6 ± 2.3	3.8	2.2 ± 1.1	0.7	3.9 ± 1.1
JoCo	3.7 ± 2.2	3.1	3.2 ± 1.0	1.0	9.1 ± 4.8

Table 5. Mean $^{234}Th_{xs}$ inventory, ^{7}Be inventory, and $^{210}Pb_{xs}$ activity in the surficial sediments on Jamaica Bay marsh islands in May-2005

Marsh Island	Mean $^{234}Th_{xs}$ Inventory (dpm cm^{-2})	$^{234}Th_{xs}$ inventory /Production *	Mean ^{7}Be Inventory (dpm cm^{-2})	^{7}Be inventory /Input**	Mean $^{210}Pb_{xs}$ Activity (dpm g^{-1})
Big Egg	2.6 ± 1.1	2.2	1.9 ± 1.0	1.2	8.2 ± 2.4
Elders Point	0 ± 0	0	1.8 ± 1.1	1.1	0.2 ± 0.2
JoCo	3.2 ± 2.9	2.7	2.3 ± 1.5	1.4	3.9 ± 1.1
East High	0 ± 0	0	1.3 ± 0.7	0.8	3.8 ± 3.1
Yellow Bar	9.8 ± 4.3	8.2	0.7 ± 0.4	0.4	0.9 ± 0.7
Little Egg	2.1 ± 2.1	1.8	0.8 ± 0.2	0.5	0 ± 0

* Mean production of ^{234}Th in the subtidal zone (1.2 dpm cm^{-2}) is used for normalization (see text for discussion).

** Relative to direct atmospheric input of ^{7}Be.

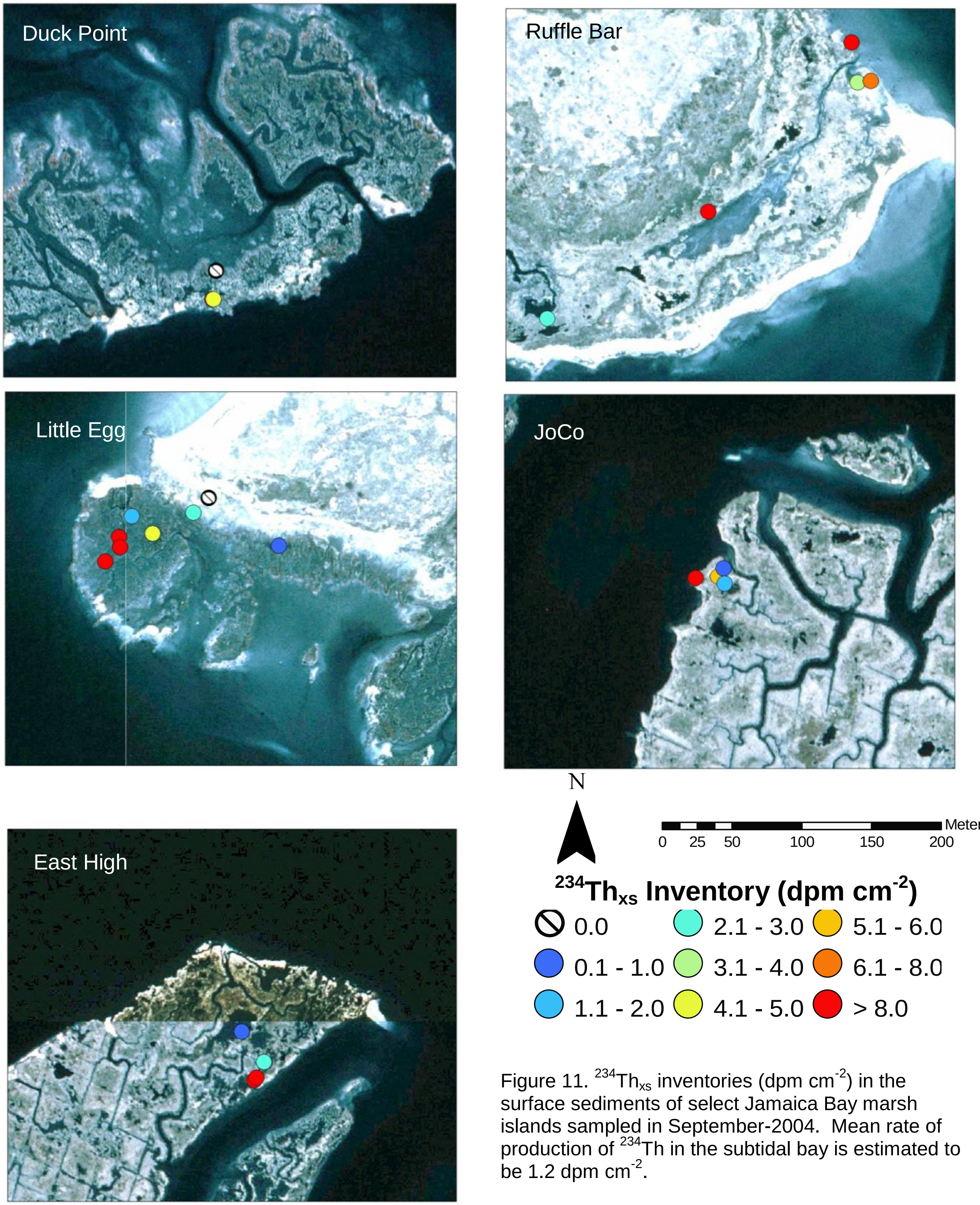


Figure 11. $^{234}Th_{xs}$ inventories (dpm cm^{-2}) in the surface sediments of select Jamaica Bay marsh islands sampled in September-2004. Mean rate of production of ^{234}Th in the subtidal bay is estimated to be 1.2 dpm cm^{-2}.

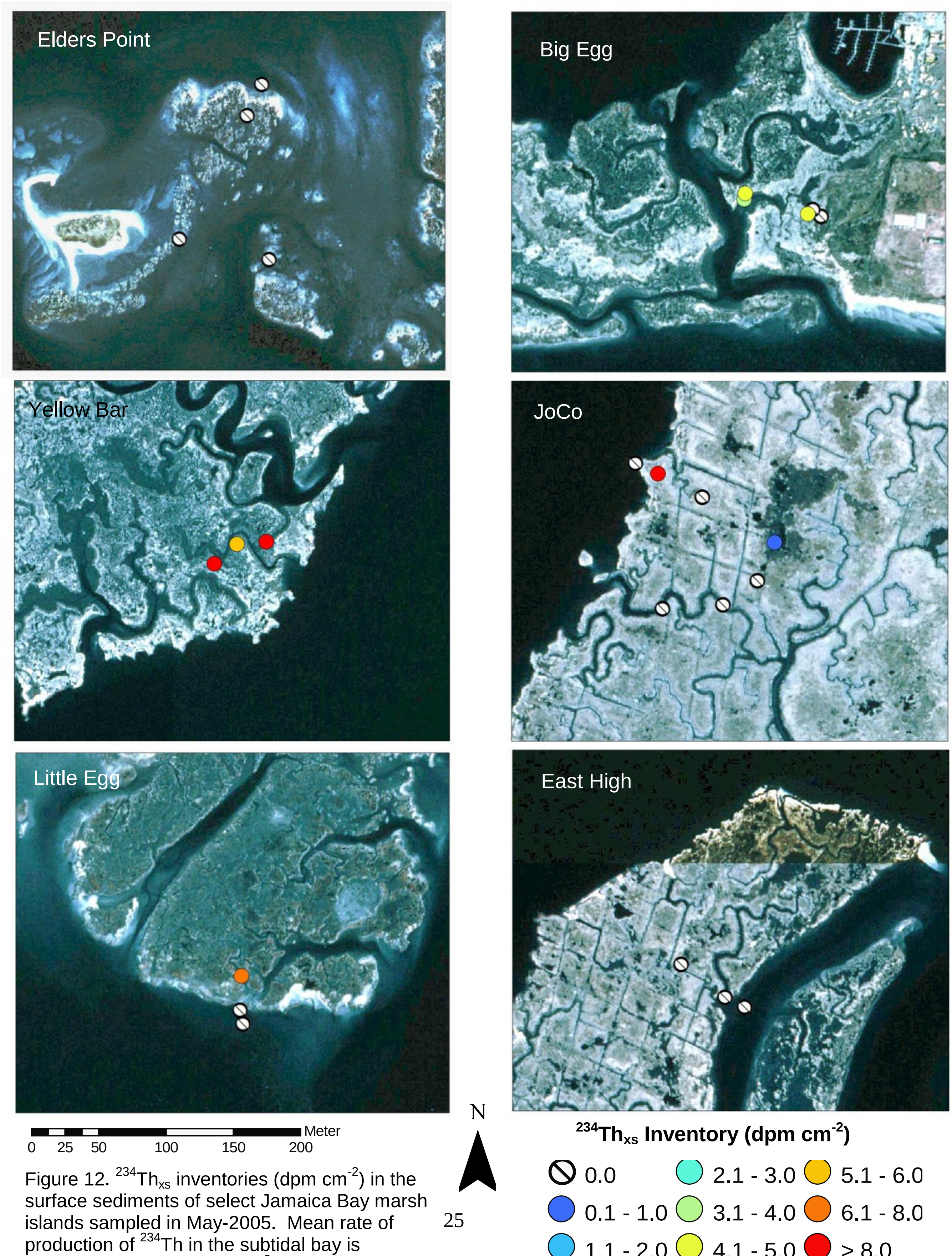


Figure 12. $^{234}Th_{xs}$ inventories (dpm cm^{-2}) in the surface sediments of select Jamaica Bay marsh islands sampled in May-2005. Mean rate of production of ^{234}Th in the subtidal bay is estimated to be 1.2 dpm cm^{-2}.

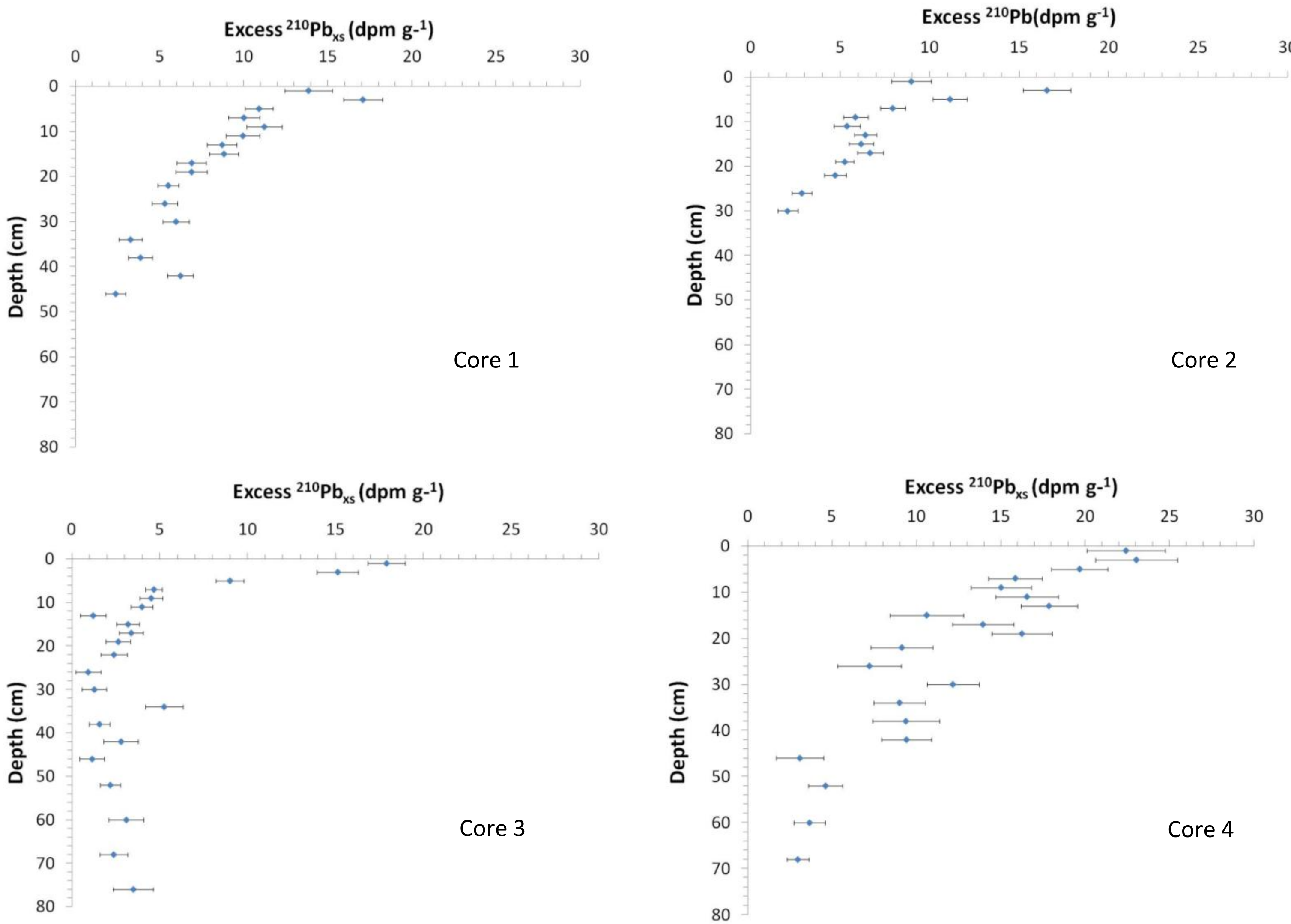


Figure 13. Excess ^{210}Pb activity vs. depth for gravity cores taken in Jamaica Bay

Table 6. Inventories of $^{210}Pb_{xs}$ in gravity cores and accumulation rates estimated from $^{210}Pb_{xs}$ and ^{137}Cs

Core #	Description	Water Depth (m)	$^{210}Pb_{xs}$ Inventory (dpm cm^{-2})	Accumulation Rate (estimated from $^{210}Pb_{xs}$) (cm y^{-1})	Accumulation Rate (estimated from ^{137}Cs)* (cm y^{-1})	Mass Accumulation Rate (g cm^{-2} yr^{-1})
1	east of Broad Channel	4.7	246 ± 21	0.92 ± 0.08	0.86	0.71
2	Southeastern Channel	5.8	168 ± 20	0.52 ± 0.09	-	0.48
3	Thurston Basin	8.0	333 ± 56	0.14 ± 0.01	-	0.01
4	Grassy Bay	11.4	187 ± 35	1.04 ± 0.09	1.04	0.31
5	Grassy Bay	9.3	193 ± 25	0.79 ± 0.06	0.68	0.40
6	Floyd Bennett Field	13.0	270 ± 26	1.11 ± 0.03	-	0.89
7	Northwestern Bay	12.7	351 ± 39	1.02 ± 0.01	1.18	0.64
8	Northern Bay	9.6	206 ± 23	0.45 ± 0.01	0.38	0.32

* estimated from 1963 ^{137}Cs peak

Discussion

Import of ^{234}Th

$^{234}Th_{xs}$ is produced within Jamaica Bay by the decay of its parent isotope, ^{238}U, which is generally conservative with salinity. This allows for production of ^{234}Th in the water column tobe estimated from salinity:

$$\text{Expected } ^{234}Th_{xs} \text{ inventory} = (A_{238})\, H \qquad (4)$$

Where A_{238} is the dissolved ^{238}U activity (dpm cm^{-3}) estimated from the salinity and H is the water depth in cm. Using an observed salinity range of 21 up to 32 and average depth of 5 meters (Benotti et al., 2007), the estimated ^{234}Th produced within the bay from the decay of dissolved ^{238}U ranges from ~0.8 – 1.2 dpm cm^{-2}. Thus complete scavenging of ^{234}Th produced within the bay should result in sediment inventories of $^{234}Th_{xs}$ of ~0.8-1.2 dpm cm^{-2}. However, the mean $^{234}Th_{xs}$ inventories in the bottom sediments of Jamaica Bay during all sampling cruises range from 3.4 – 5.6 dpm cm^{-2} (Table 1). The sampling intensity is sufficient to indicate that this phenomenon of "surplus" inventory relative to that expected from ^{238}U decay within the bay occurs bay-wide. Such surplus inventories can be produced in only two ways: import of particles with associated $^{234}Th_{xs}$ into the bay and/or tidal exchange of water with dissolved ^{234}Th that is transported into the bay, scavenged onto particles and then deposited.

To assess the possible import of $^{234}Th_{xs}$ in association with particles, activities were measured on particles filtered from the water column at 4 stations in September-2008 during a flooding tide (Figure 6.; Table 2). $^{234}Th_{xs}$ activities are highest at the inlet station (14.8 ±1.0 dpm g^{-1}) and just within the bay in the deep water (5.5 ± 0.6 dpm g^{-1}). These high activities on the suspended particles at these locations suggest that excess ^{234}Th is imported into the bay from the ocean associated with particles. Total ^{234}Th (particulate + dissolved) also was measured in the bay, and Table 2 indicates that virtually all of the ^{234}Th in water samples taken within the bay is particulate. However, samples at the inlet mouth have ~0.2 dpm dissolved ^{234}Th L^{-1}, and this may be imported tidally into the bay, where it would be scavenged and deposited. Given the tidal exchange of water (6.06 x 10^{10} L/tidal cycle x 1.91 tidal cycles/d; Beck et al., 2007), Renfro (2009; PhD thesis, in preparation) estimates that import and scavenging of dissolved ^{234}Th into Jamaica Bay adds ~2 dpm cm^{-2} to the sediment inventories.

If we assume that sediment inventories of $^{234}Th_{xs}$ greater than the value expected from scavenging and deposition of ^{234}Th produced from ^{238}U decay within the bay + dissolved ^{234}Th imported tidally are produced by tidal importation of particles with $^{234}Th_{xs}$, we can calculate the mass flux of particles (g y^{-1}) required to produce the surplus:

$$\text{Sediment import} = (I_{Th}'/A_{Th}) \times \lambda_{Th} \times \text{subtidal bay area} \qquad (5)$$

where I_{Th}' is the mean surplus $^{234}Th_{xs}$ inventory in the bottom sediments relative to that expected from scavenging of dissolved ^{234}Th produced within the bay and imported tidally (0.2 – 2.4 dpm cm^{-2}), A_{Th} is the $^{234}Th_{xs}$ activity of particles in the water column measured at the bay inlet (14.8 dpm g^{-1}; Table 2), λ_{Th} is the decay constant of ^{234}Th (yr^{-1}), and the area of the subtidal bay is 39

km^2 (estimated from Hartig et al., 2002). Using the mean inventory during each of the sampling cruises, estimates of particle import from the ocean to the subtidal bay range from 5.6×10^{10} to 6.7×10^{11} g y^{-1}.

An earlier attempt at a sediment budget for inorganic silt and clay in Jamaica Bay (Bokuniewicz and Ellsworth, 1986) required an input of $1.5 – 2.9 \times 10^{10}$ g y^{-1} (15 – 29 thousand MT y^{-1}) to bring the bay's sediment budget into balance. This sediment budget included estimates of sediment sources due to *in situ* production (0.1×10^{10} g y^{-1}), and sewage treatment plants (0.5×10^{10} g y^{-1}). The importation of fine-grained sediment through Rockaway Inlet seemed to be the dominant sediment source. Sediment sinks included deposition in dredged channels (0.1×10^{10} g y^{-1}) subtidal areas ($0.6 – 1.5 \times 10^{10}$ g y^{-1}) and marshes ($1.5 – 2.0 \times 10^{10}$ g y^{-1}). Evidence for the importation of sediment has been documented in other estuaries in the region, such as Long Island Sound (Bokuniewicz et al., 1976), Newark Bay (Suszkowski, 1978), the Hudson River estuary (Ellsworth, 1986), and the Raritan River estuary (Renwick and Ashley, 1984)

Direct evidence of sediment importation into Jamaica Bay was subsequently based on simultaneous measurements of water velocity by ADCP and suspended sediment concentrations across Rockaway Inlet over one tidal cycle on 30 September/1 October, 1995 (Lwiza and Bokuniewicz, unpublished data); a single tide can import 3.6×10^6 g of sediment into the Bay under the right conditions, resulting in an estimated yearly import of 2.6×10^{10} g y^{-1}. The difference in the estimated annual import of sediment from these two studies may suggest enhanced import of suspended sediments from the ocean during spring tides and storm events. As well, because conditions vary, some tides will carry in less material and some will export sediment from the bay to the ocean. Both the direct estimates of sediment transport and those based on the ^{234}Th mass balance strongly indicate that an import of sediment from the ocean into Jamaica bay occurs. That the ^{234}Th-based estimates are somewhat greater than the sediment balance estimates likely reflects the fact that only a limited sampling of suspended particles was carried out (e.g. subsequent sampling of particles at the inlet has shown higher $^{234}Th_{xs}$ activities; Renfro, 2009) and storm events might have biased the magnitude of the surplus ^{234}Th inventories. As well, ^{234}Th integrates over relatively short time intervals (a few months) and it is difficult to extrapolate to annual time scales on the basis of a few seasonal samplings.

The spatial distribution and magnitude of $^{234}Th_{xs}$ inventories in the surficial bottom sediments as measured during the May-2005 and November-2005 cruises (Figure 9.B, C) may, in part, reflect changes in the import of fine-grained particles from the ocean, as well as redistribution of surficial sediment within the bay. In general there is a seasonal pattern to storm activity off the coast of Long Island, with more frequent storms occurring during winter and early spring, resulting in higher significant wave heights (Figure 14.). Storm activity and the increase in significant wave heights off the coast also may be observed within the bay. While ocean waves would not impact the Bay directly, storm winds, especially from the northeast, would produce wind-driven waves in the bay and resuspend bottom sediment. Tidal, estuarine and wind-driven currents would then redistribute suspended sediments ultimately for deposition in deeper waters of the bay, and, possibly, to salt marshes. There are two tidal gauges in Jamaica Bay, one at Inwood Park and the other at Rockaway Inlet (Figure 15.). The rate of change of the difference in mean daily tidal height between these two stations indicates flow of water between the eastern

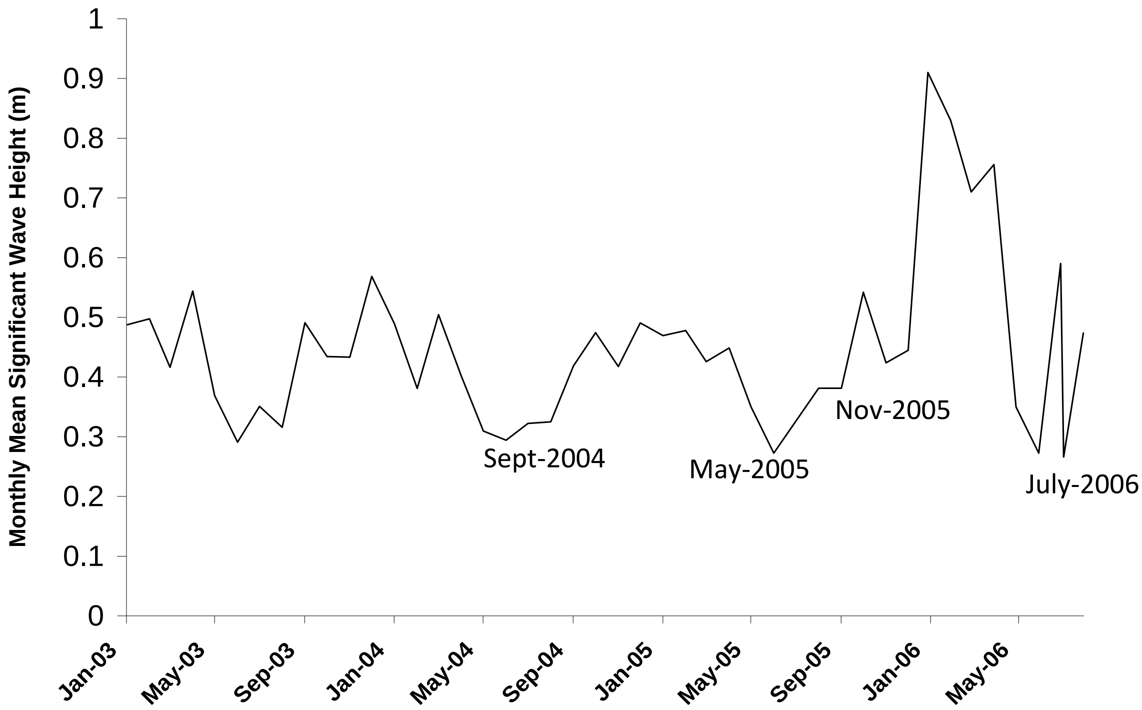


Figure 14. Significant wave height at the NOAA ALSN6 Buoy from January 2003 to August 2006.

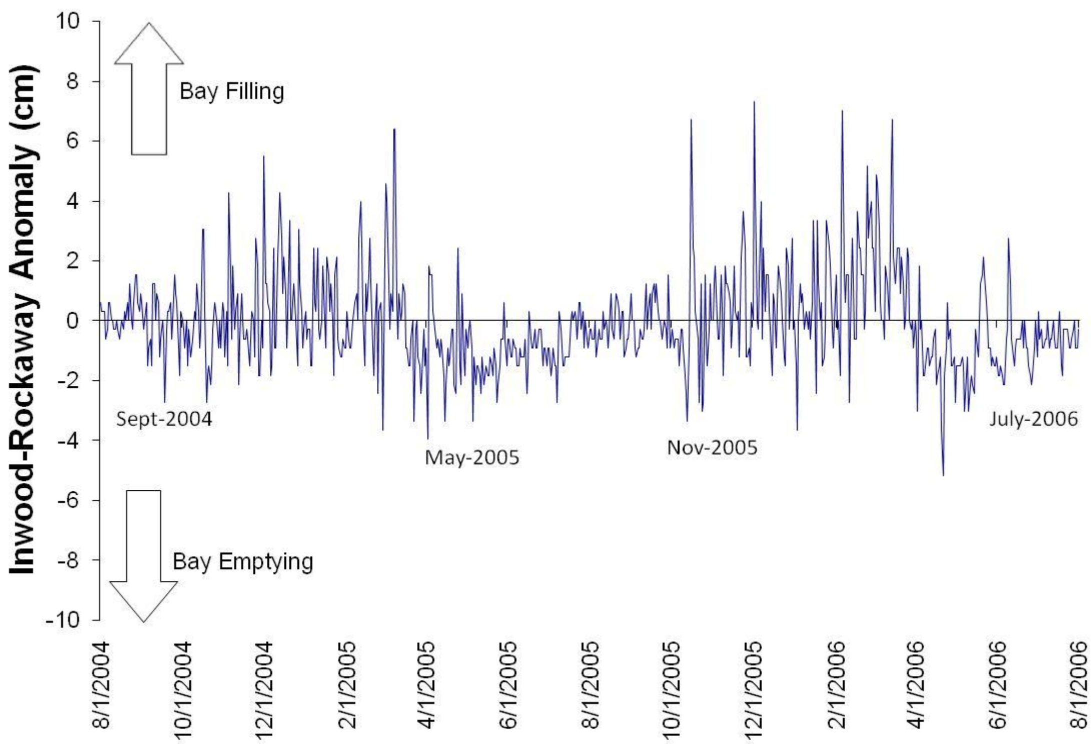


Figure 15. Mean daily tidal height difference between Inwood and Rockaway tidal stations.

and western bay. If the mean daily tidal height at the eastern station (Inwood) is increasing with respect to that at Rockaway, water is being pushed into the bay from the ocean by wind and waves.

$^{234}Th_{xs}$ inventories in the surficial bottom sediments during the May-2005 cruise were high near the western marsh islands, while inventories were lower in the eastern part of the bay, particularly in Grassy Bay (northeastern part of Jamaica Bay; Figure 9.B).). Prior to the sampling cruise in May-2005, winds recorded at JKF Airport were of low velocity and from the south (Figure 16.). In addition, the tidal anomaly between the Inwood and Rockaway tidal stations suggests a flow of water out of the bay. These conditions may have prevented transport of sediment and associated ^{234}Th to the eastern part of the bay, particularly Grassy Bay, and even may have resulted in transport of ^{234}Th produced by the decay of ^{238}U in the eastern part of the bay to the western bay.

$^{234}Th_{xs}$ inventories in subtidal sediments in November-2005 were high near the western marshes, but were also high in Grassy Bay (Figure 9.C). In contrast to May-2005, there was a large storm event prior to the November-2005 sampling. This storm event resulted in higher significant wave heights offshore at the ALSN6 buoy station (Figure 14.). Strong local winds out of the southeast, along the long axis of the bay, would have increased wave action in the bay, while the water surface of Jamaica Bay rose at the Inwood station suggesting that water was being pushed into the bay (Figure 15.). These conditions may have increased the overall import of ocean-derived sediment and associated ^{234}Th into the bay, as well as increased the ^{234}Th and sediment transport to the eastern part of the bay.

Overall, the spatial patterns of $^{234}Th_{xs}$ inventories in bottom sediments of Jamaica Bay suggest deposition in the western part of the bay during quiescent periods, with transfer of particles and associated ^{234}Th to the eastern, deeper parts of the bay during and following times of storm activity. These periods also may offer opportunities for sediment supply to marshes within the bay (Stumpf, 1983; Roman et al. 1997). Inventories of ^{7}Be show a temporal pattern similar to that of ^{234}Th, but the distribution is complicated by enhanced input of this cosmogenic radionuclide to the bay following storm-induced CSO events (Appendix A).

The spatial pattern of deposition rates of sediment imported from the ocean into Jamaica Bay may be estimated by modifying equation 5 to:

$$\text{Sediment deposition rate} = (I_{Th}'/A_{Th}) \times \lambda_{Th} \qquad (6)$$

where I_{Th}' is the $^{234}Th_{xs}$ inventory in surplus of local production within the bay (1.2 dpm cm^{-2}) and import of dissolved ^{234}Th through the inlet (2.0 dpm cm^{-2}; see eqn. 5), A_{Th} is the activity of ^{234}Th on suspended particles at Rockaway Inlet (14.8 dpm g^{-1}), and λ_{Th} is the decay constant of ^{234}Th ($month^{-1}$). This calculation assumes that each site will have a minimum $^{234}Th_{xs}$ inventory equal to the production in the overlying water column, and that this inventory is maintained by resuspension, scavenging, and re-deposition rates by the net input of sediment. The surplus inventory is assumed to result from deposition of new sediment to the site. The resulting deposition at each sample site is then given in g cm^{-2} $month^{-1}$. We use "month" in this calculation to emphasize that these deposition rates represent short-term (e.g. seasonal) values.

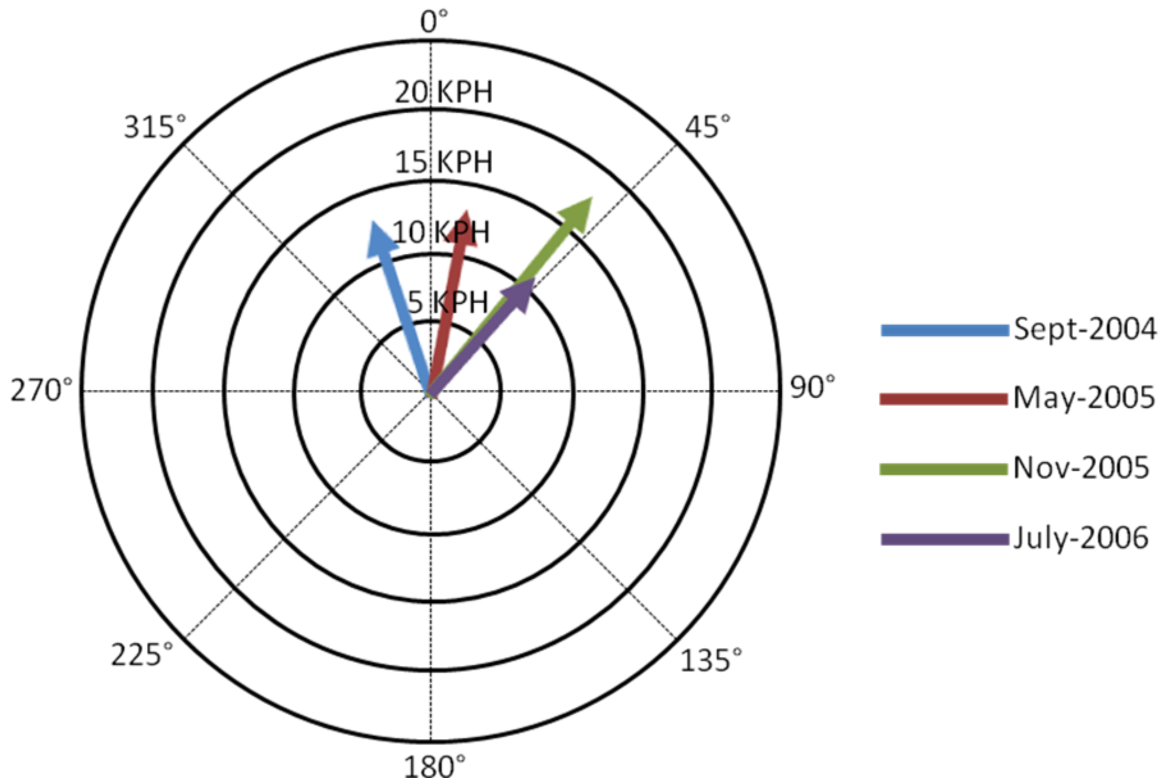


Figure 16. Mean wind speed (km h^{-1}) and wind direction for the 24 days preceding the sampling cruises in September-2004, May-2005, November-2005, and July-2006. Arrows indicate direction in which wind is blowing

Using this method, the mean deposition rates of sediment imported from the ocean are 0.14 ± 0.04, 0.06 ± 0.03, 0.10 ± 0.03, and 0.02 ± 0.01 for the September-2004, May-2005, November-2005, and July-2006 cruises, respectively.

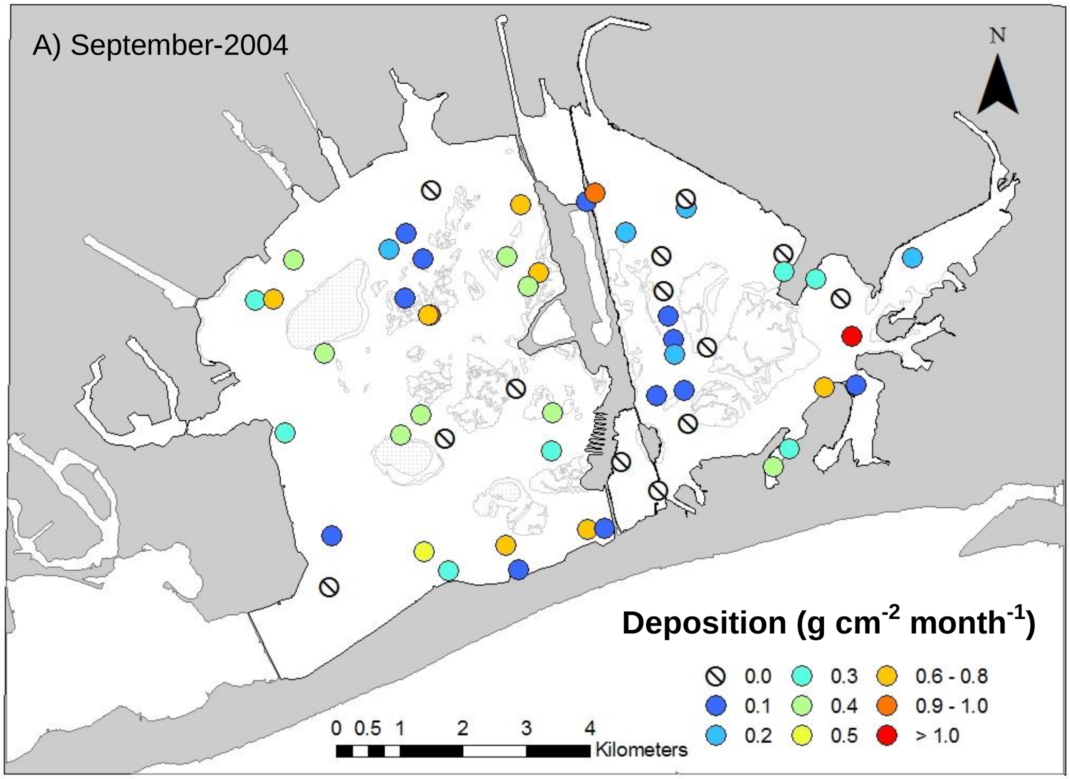
Deposition rates of imported sediment (g cm^{-2} $month^{-1}$) naturally reflect the distribution of $^{234}Th_{xs}$ inventories for the sampling cruises. High deposition rates of sediment imported from outside the bay occurred near the western marshes during September-2004, May-2005, and November-2006 (Figure 17.A, B). High deposition occurred in the eastern part of the bay during November-2005 and July-2006 cruises (Figure 17.C, D). As noted above, prior to both of these cruises high significant wave heights were observed at the ALSN6 buoy. These results suggest that storm events are likely important in transporting sediments from the oceans to the far eastern part of the bay, particularly Grassy Bay.

Long-Term Sediment Accumulation Rates

Gravity cores were taken at 8 locations (Figure 6.) to determine long-term accumulation rates throughout Jamaica Bay. Sediment accumulation rates based on $^{210}Pb_{xs}$ profiles ranged from 0.14 ± 0.01 to 1.11 ± 0.03 cm yr^{-1}. Mass accumulation rates have been calculated from multiplying the accumulation rate at each site by the mean dry bulk density at that site and values range from 0.31 – 0.89 g cm^{-2} y^{-1} (excluding the Thurston Basin core; Table 6, Figure18.). The high accumulation rates were measured at sites 6 and 7 in the western part of the bay, and these two sites also had the deepest water depth of all stations sampled (Table 6). This suggests that once sediment settles into these deep sites, it is not likely to be resuspended and transported to other locations within the bay. The high accumulation rates at these locations are consistent with high $^{210}Pb_{xs}$ activity in the upper 5 cm of subtidal sediments sampled during the September-2004, May-2005, and November-2005 cruises (Figure 10.).

High accumulation rates were also observed in the eastern part of the bay at stations 1, 4, and 5 (Figures 6., 18.). The eastern part of the bay, particularly Grassy Bay, has limited connection to the western bay, and in turn, the ocean. However, high accumulation rates within and near Grassy Bay suggest that sediment is, at least periodically, transported to the eastern bay. Excess ^{210}Pb activities in subtidal sediments were consistently high in this region during all sampling cruises (Figure 10.). However, the short-lived radionuclide ^{234}Th was low in Grassy Bay during the September-2004 and May-2005 cruises, but was high November-2005 and July-2006. As noted above, significant wave height outside the bay at buoy station ALSN6 increased prior to both of these sampling cruises. These results further support the notion that storm events may play an important role in moving sediment to the eastern part of the bay. Once deposited in this deep area of the bay it is unlikely that conditions would exist to resuspend sediment and transport elsewhere in the bay.

The lowest accumulation measured was at site 3 in Thurston Basin, in the far eastern part of the bay (Figure 18.). At this site there seems to be a distinct change in deposition rate with depth in the core, as seen in the change in the slope of the $^{210}Pb_{xs}$ vs. depth plot at ~7 cm (Figure 13.). In the upper 7 cm, the accumulation rate was low (0.14 ± 0.01 cm yr^{-1}), while deeper in the core (9 – 30 cm) the accumulation rate was higher (0.80 ± 0.02 cm yr^{-1}). A significant change in the



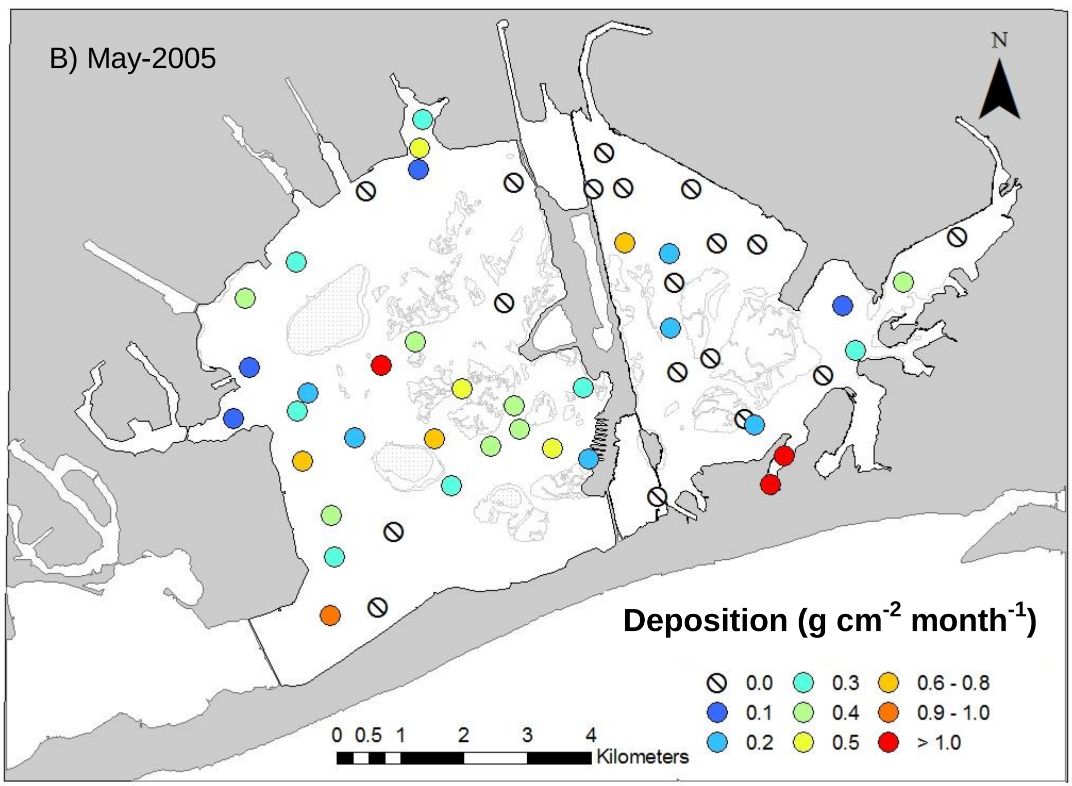
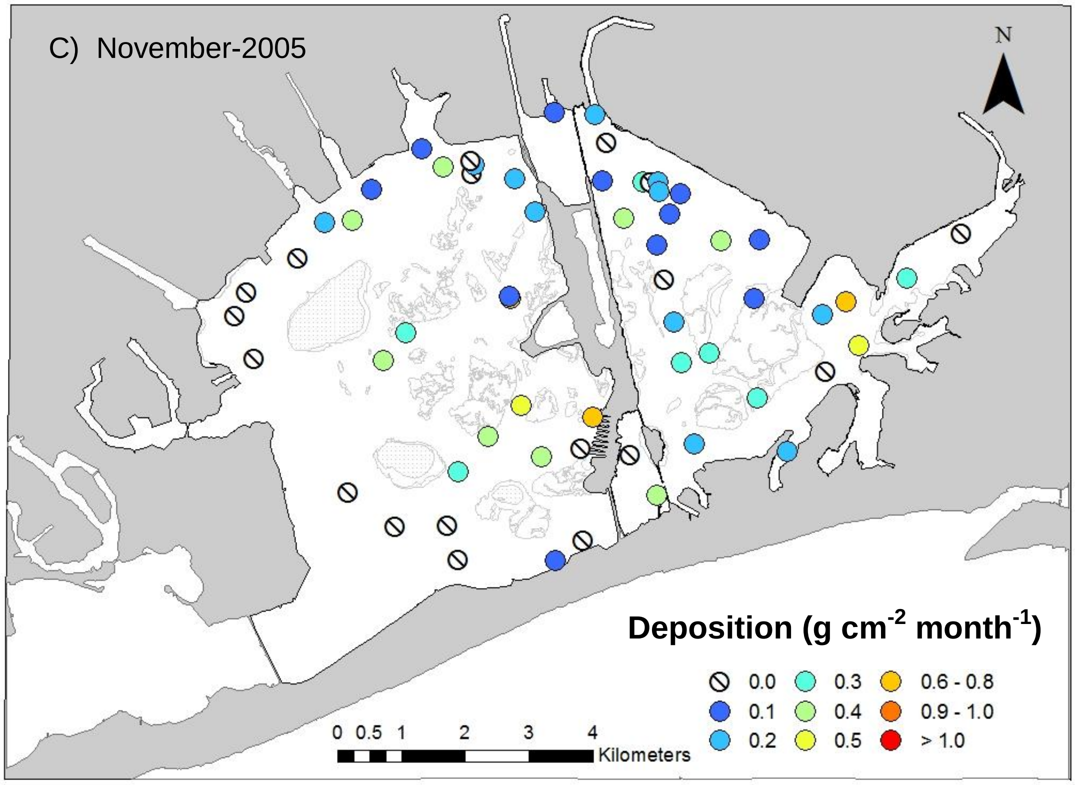


Figure 17. Deposition of sediment imported into the bay from the ocean as estimated using $^{234}Th_{xs}$ inventories in surplus to that produced within the bay during A) September-2004, B) May-2005, C) November-2005, and D) July-2006 cruises.



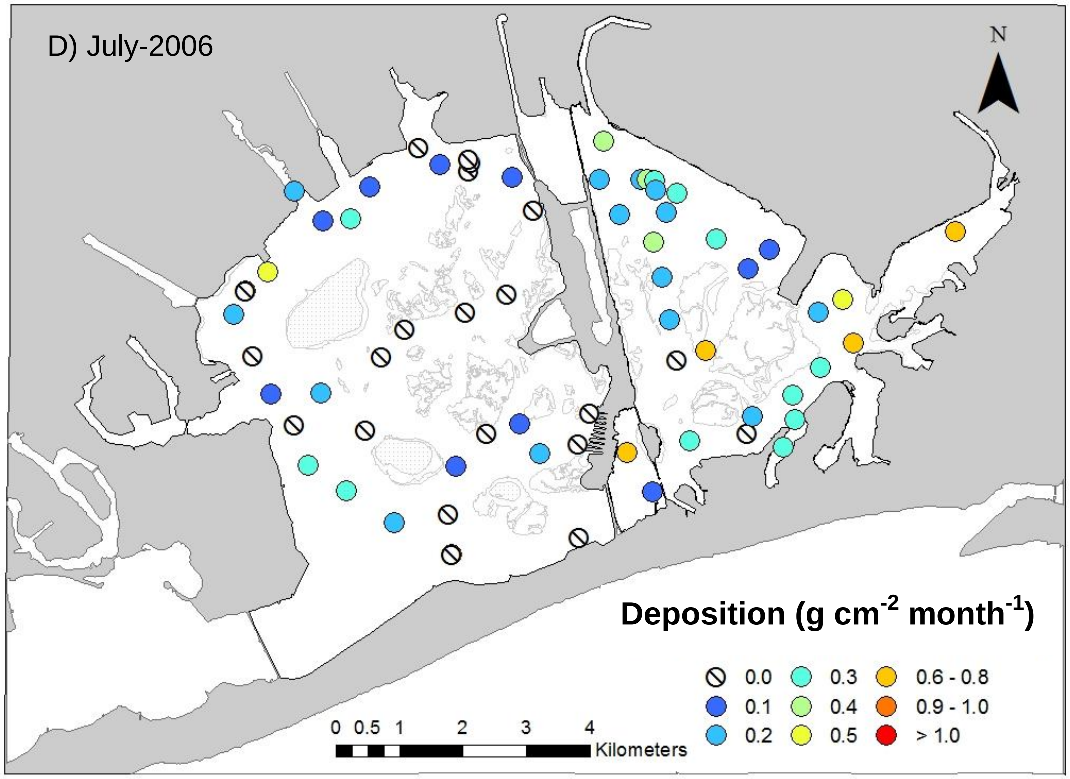


Figure 17. Continued

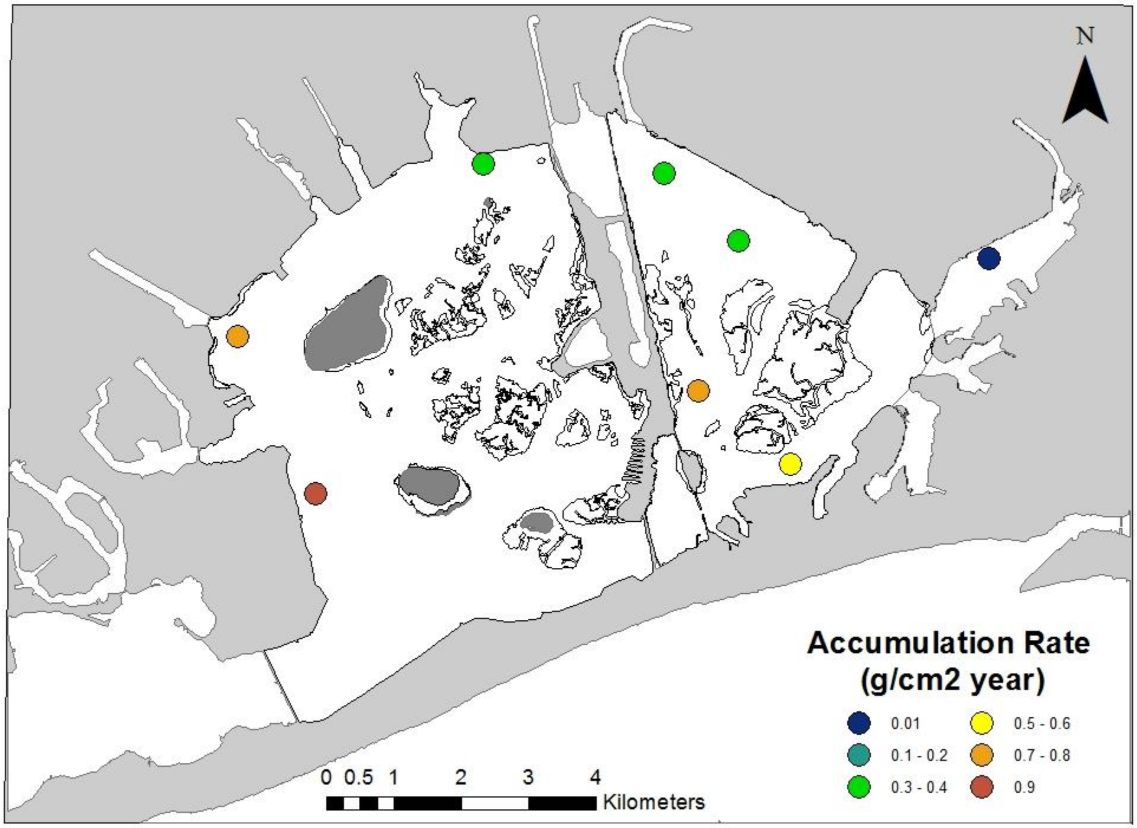


Figure 18. Sediment accumulation rate (g cm^{-2} yr^{-1}) determined from ^{210}Pb accumulation rates and sediment bulk density.

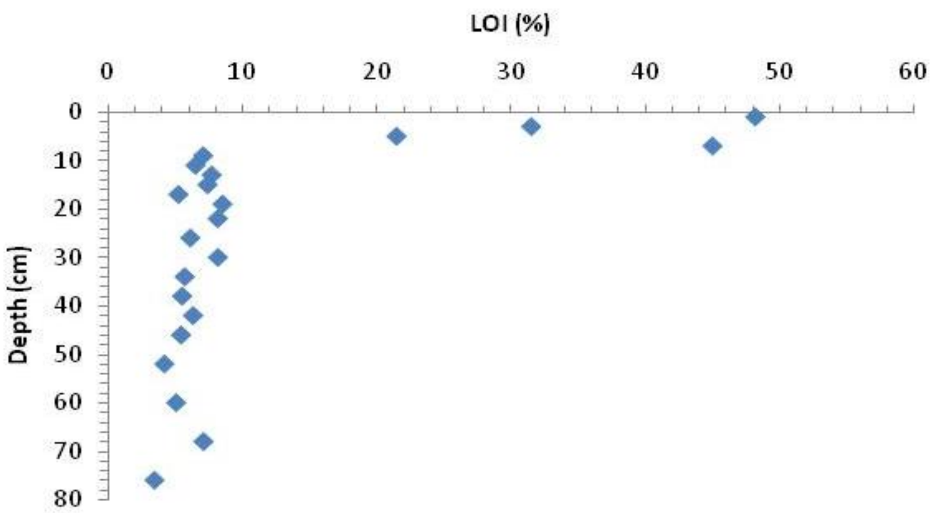


Figure 19. Gravity core 3- LOI (loss-on-ignition) vs. depth in core. High organic content was measured in the upper 7 cm.

organic content of the core also occurs in the upper 7 cm: LOI is high (> 20%) in this zone, but below this depth, the organic content is consistently < 10% (Figure 19.). These results suggest that a change in sediment delivered to this site occurred ~50 years ago. This change may reflect increased development (e.g. paving) in the upland region surrounding this site, limiting the inorganic sediment transported to the bay from runoff. The change in accumulation rate and sediment type at this location is perhaps more noticeable due to the site's isolation from much of the rest of the bay.

The mass accumulation rates derived from excess ^{210}Pb profiles (0.31 – 0.89 g cm^{-2} y^{-1}; Figure 18.) may be compared with those from surplus $^{234}Th_{xs}$ inventories (Figure 17.). For example, in Grassy Bay the ^{210}Pb-derived mass accumulation rate is ~0.3 – 0.4 g cm^{-2} y^{-1}. Rates derived from $^{234}Th_{xs}$ inventories range from 0 to 0.2 g cm^{-2} month^{-1} (0 to 2.4 g cm^{-2} y^{-1}). The average mass accumulation rate determined from the ^{210}Pb data (mean ± 1σ = 0.47 ± 0.27 g cm^{-2} y^{-1}) compares relatively well with the range estimated from the ^{234}Th balance (0.14 – 1.7 g cm^{-2} y^{-1}; section 4.1). This calculation assumes that the sediment is distributed uniformly over the subtidal portion of the bay (39 km^2). While the two estimates are in reasonable agreement given the assumptions of the methods, it is likely that the ^{234}Th estimates are biased toward the high side because they represent short-term patterns of deposition which cannot be extrapolated to a full year. This is consistent with the pattern evident in the sediment $^{234}Th_{xs}$ inventories (Figure 9.) of seasonal transport of sediment into Grassy Bay and other eastern portions of Jamaica Bay. ^{210}Pb profiles in the sediments, with a sampling resolution of ~2-8 years, effectively integrate over these seasonal sediment transport events.

$^{210}Pb_{xs}$ inventories in the gravity cores range from 167 to 351 dpm cm^{-2} and show large surpluses relative to the inventory expected from direct atmospheric input of ^{210}Pb (~32 dpm cm^{-2}; Benninger, 1978, Turekian et al., 1983). This suggests that there are additional sources of ^{210}Pb into the sediments of Jamaica Bay. High $^{210}Pb_{xs}$ activity on suspended particles at Rockaway Inlet (Table 2) indicates that $^{210}Pb_{xs}$, like $^{234}Th_{xs}$, is associated with particles that may be imported into the bay from the ocean. In addition, there may be $^{210}Pb_{xs}$ input from the Jamaica Bay "sewershed". Much of the freshwater input into Jamaica Bay is from the wastewater treatments plants located around the bay. During rainfall events, it is likely that ^{210}Pb is scavenged from the atmosphere both directly into the bay and to the urban area surrounding the bay where it can become associated with particles. During heavy rainfall events the wastewater treatment facilities can become overloaded due to surface runoff from the streets. Under such conditions the plants are bypassed, resulting in untreated wastewater and storm water entering the bay. The ^{210}Pb and the particles it is associated with can then be deposited in the bay resulting in ^{210}Pb inventories far in excess to the expected from direct atmospheric input. In effect, New York City acts as a large atmospheric collector for atmospherically-supplied ^{210}Pb (and ^{7}Be; see Appendix A), which is transported into Jamaica Bay during CSO events.

Radionuclides and Marsh Islands

The ability of salt marshes to keep pace with rapidly rising sea level is partially dependent on the rate of sediment supply to the marsh (Redfield, 1965). The rate of sediment deposition on marshes is affected by sediment availability, frequency with which the marsh surface is inundated by water, length of the inundation, and proximity to the source of material (Friedrichs and Perry, 2001). Kolker (2005) measured ^{210}Pb profiles in East High, Big Egg and JoCo marshes and found recent (~1999-2001) accretion rates of 0.25, 0.41 and 0.35 cm y^{-1}, respectively. These rates suggest that, over the long-term, the three marsh sites are accreting to keep pace with rising sea level (~0.3 cm y^{-1}), although their change in surface elevation may not keep pace (as observed elsewhere; Cahoon et al., 1999). The dry bulk densities of these marsh sediments are all ~0.2 g cm^{-3}, yielding mass accretion rates of ~0.05 – 0.08 g cm^{-2} y^{-1}. These rates are about 10% of those in the fine-grained subtidal portions of the bay. Thus, while the marshes of Jamaica Bay are receiving sediment that allows them to accrete to keep pace with sea level, the possibility exists that as artificially deepened basins such as Grassy Bay fill in, sediment may become more available to the marsh surfaces.

$^{234}Th_{xs}$ inventories in marsh sediments provide another approach to examining sediment supply to the marsh surface. This is because ^{234}Th is produced in the water of the bay by the decay of it parent isotope ^{238}U (conservative with salinity; see section 3.2), and the inventory of ^{234}Th expected in the sediments is thus a function of salinity and water depth. Although some production of ^{234}Th may occur in water overlying a flooded marsh surface, the length of time the marsh is flooded, and more importantly the depth of the water, would be minimal. As a result, $^{234}Th_{xs}$ inventories would be expected to be minimal in marsh peat, and values significantly greater than zero would indicate that particles from the subtidal bay have been deposited on the marsh surface. $^{234}Th_{xs}$ inventories during the September-2004 and May-2005 samplings often were substantial (Figures 11. and 12.), with mean values of 6.5 ± 1.4 dpm cm^{-2} and 3.8 ± 1.1 dpm cm^{-2}, respectively (Table 3). Figures 11. and 12. show that there is both temporal and spatial variation in $^{234}Th_{xs}$ inventories within a marsh. Stations in the interior of a marsh often display low $^{234}Th_{xs}$ inventories (e.g. Little Egg and Duck Point in September-2004, Figure 12.; JoCo, Big Egg and East High in May-2005, Figure 13.) but the complex nature of marsh drainage makes it difficult to generalize. There are also temporal differences, with greater $^{234}Th_{xs}$ inventories observed, on average, during the September-2004 sampling (Table 3). Another aspect of the spatial trend is that marshes in the western bay have higher mean inventories than marshes in the eastern bay (Table 3). These data are consistent with the same processes controlling the surplus $^{234}Th_{xs}$ inventories in subtidal sediments, namely import of sediment with elevated $^{234}Th_{xs}$ activities into the bay via Rockaway Inlet (Table 2) and seasonal transport of sediment (and $^{234}Th_{xs}$) in conjunction with high wave and storm activity.

We have converted the marsh $^{234}Th_{xs}$ inventories into short-term mass accretion rates using an approach similar to eqn. 6. The calculation uses the average ^{234}Th production in the bay (1.2 dpm cm^{-2}) as a point of reference for calculating the surplus inventories in the marsh sediments. Figures 20. and 21. show mass deposition rates of ~0 – 1 g cm^{-2} $month^{-1}$. As with the subtidal sediments, values at the higher end of this range can not be sustained for long periods (many months to years). The ^{234}Th-derived deposition rates are reasonably consistent with the ^{210}Pb-derived values cited above in JoCo, East High and Big Egg marshes if it is assumed that the sampling in Septermber-2004 and May-2005 are snapshots representing short-term deposition of sediment (and ^{234}Th) on the marsh surface, driven by tidal excursions and seasonal patterns of flooding. In contrast to the pattern seen in $^{234}Th_{xs}$ inventories, the ^{7}Be inventories are somewhat less variable both spatially and temporally (Table 3). This is consistent with the supply of this radionuclide directly from the atmosphere to the marsh surface (as for ^{210}Pb). Unlike ^{234}Th, ^{7}Be is less dependent on tidal flooding to supply it to the marsh.

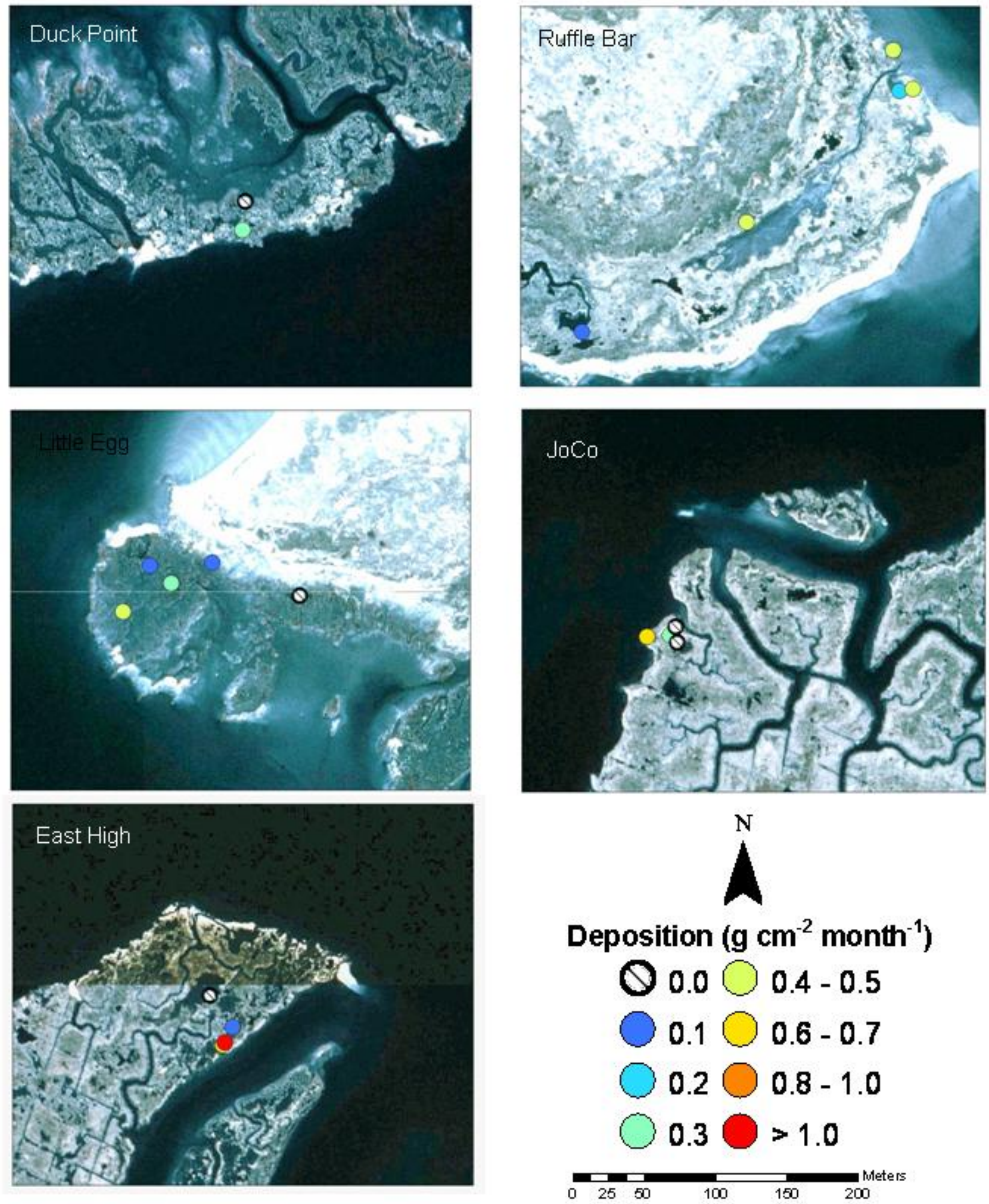


Figure 20. Deposition of sediment on marsh sites, estimated using $^{234}Th_{xs}$ inventories in surplus to that produced within subtidal bay during September-2004 marsh sampling.

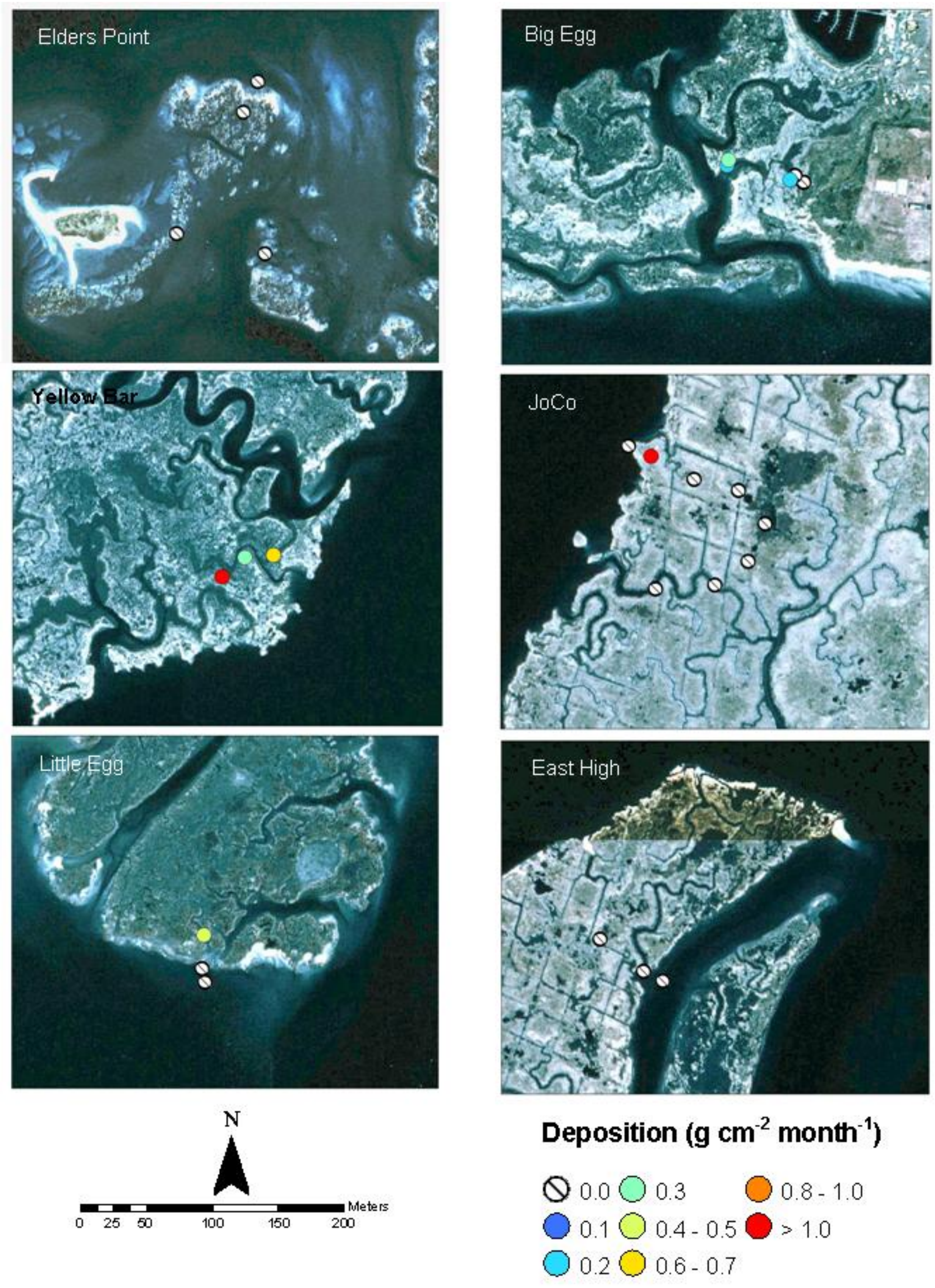


Figure 21. Deposition of sediment on marsh sites, estimated using $^{234}Th_{xs}$ inventories in surplus to that produced within subtidal bay during May-2005 marsh sampling.

Summary and Conclusions

This study has used mass balances and spatial distributions of the natural radionuclides ^{234}Th, ^{7}Be and ^{210}Pb in Jamaica Bay sediments as indicators of sediment transport and deposition within the bay. All three radionuclides show surpluses in their inventories in bay sediments relative to those expected from the known sources (production from decay of dissolved ^{238}U and scavenging for ^{234}Th and direct deposition to the bay from the atmosphere and scavenging for ^{7}Be and ^{210}Pb.) The balances for ^{210}Pb and ^{7}Be are complicated by the fact that both radionuclides apparently have been transported into the bay in association with combined sewer overflow (CSO) events. For $^{234}Th_{xs}$, however, the surplus inventories must be due partially to import of particles into the bay. (Tidal exchange of water from outside the bay with dissolved ^{234}Th that is scavenged and deposited within the bay also is a likely factor.) The ^{234}Th balance requiring import of sediment to the bay is in qualitative agreement with previous estimates of the sediment balance in the bay, which also show importation of sediment. Seasonal distributions of $^{234}Th_{xs}$ inventories in bottom sediments of the bay show that sediment is deposited in the western portions of the bay during quiescent periods, but is transferred to the eastern portions, especially to Grassy Bay, following periods of storm activity accompanied by winds blowing to the northeast. Sediment also may be transferred to salt marshes during storm events that redistribute sediment in the bay (Roman et al., 1997). Indeed, some of the marsh sites sampled in this study display significant inventories of $^{234}Th_{xs}$, indicating that subtidal sediments are transferred onto them, at least on short time scales.

Deposition patterns of sediment on longer time scales (decadal) are apparent from down-core distributions of $^{210}Pb_{xs}$ in sediment cores. Long-term sediment accumulation rates range from ~0.4 – 1.2 cm y^{-1} (~0.3 – 0.9 g cm^{-2} y^{-1}) in the eastern subtidal portion of the bay, suggesting that this area serves as a long-term repository for sediment in the bay. In comparison, previous work has shown that salt marshes within the bay are accreting at recent rates of ~0.25 – 0.41 cm y^{-1} (~0.05 – 0.08 g cm^{-2} y^{-1}; Kolker, 2005). The recent marsh accretion rates derived from ^{210}Pb are in agreement with the limited sediment elevation table (SET) data from Jamaica Bay, which show accretion rates of ~0.4 cm y^{-1} in JoCo marsh (2003 – 2009, Cahoon and Lynch, unpublished data reported by P. Rafferty, National Parks Service). Although the mass accumulation rates for marshes within Jamaica Bay are less than those in the muddy subtidal sediments of the bay, such a difference is not unreasonable given the different natures of these deposits. The present study does not provide support for the idea that marsh loss in Jamaica Bay is coupled with a lack of sediment supply to the bay or marshes within it. Indeed, as the subtidal portions of the bay accumulate sediment, sediment supply to the marsh surfaces may be facilitated. Marsh loss in the bay appears to be better explained by factors other than a lack of sediment supply. Such factors may include the build-up of phytotoxins in marsh peat pore water as a result of enhanced organic loading and decomposition (Kolker, 2005).

Literature Cited

Benninger, L. K. 1978. ^{210}Pb balance in Long Island Sound. *Geochimica et Cosmochimica Acta* 42: 1165-1174.

Benotti, M. J., M. Abbene and S. A Terracciano. 2007. Nitrogen Loading in Jamaica Bay, Long Island, New York: Predevelopment to 2005. USGS Open File Report SIR 2007-5051, Reston, VA.

Bokuniewicz, H., and J. Ellsworth. 1986. Sediment budget for the Hudson system, *Journal of Northeastern Geology* 8:158-164.

Bokuniewicz, H. J., J. A. Gebert and R. B. Gordon. 1976. Sediment mass balance in a large estuary: Long Island Sound. *Estuarine and Coastal Marine Science* 4: 523-536.

Botton, M. L., R. E. Loveland, J. T. Tanacredi and T. Itow. 2006. Horseshoe Crabs (*Limulus polyphemus*) in an urban estuary (Jamaica Bay, New York) and the potential for ecological restoration. *Estuaries and Coasts* 29: 820-830.

Cahoon, D. R., D. J. Reed and J. W. Day. 1995. Estimating shallow subsidence in microtidal salt marshes of the southeastern United States: Kay and Barghoorn revisited. *Marine Geology* 128,: 1-9.

Cahoon, D. R., J. W. Day, Jr., and D.J. Reed. 1999. The influence of surface and shallow subsurface soil processes on wetland elevation: a synthesis. *Current Topics in Wetland Biogeochmistry* 3: 72-88.

Ellsworth, J. 1986. Sources and sinks for fine-grained sediment in the lower Hudson River for the Hudson system. *Journal of Northeastern Geology* 8: 141-155.

Feng, H., J. K. Cochran and D. J. Hirschberg. 1999. ^{234}Th and ^{7}Be as tracers for the sources of particles to the turbidity maximum of the Hudson River Estuary. *Estuarine, Coastal, and Shelf Science* 49: 629-645.

Ferguson, P. L., R. F. Bopp and S. N. Chillrud. 2003. Biogeochemistry of nonylphenol ethoxylates in urban estuarine sediments. *Environmental Science and Technology* 37: 3499-3506.

Friedrichs, C. T., and J. E. Perry. 2001. Tidal marsh morphodynamics, *Journal of Coastal Research* SP 27: 7-37.

Hartig, E. K., V. Gornitz, A. Kolker, F. Mushacke and D. Fallon. 2002. Anthropogenic and climate-change impacts on salt marshes of Jamaica Bay, New York City. *Wetlands* 22: 71-89.

Kolker, A. 2005. The impacts of climate variability and anthropogenic activities on salt marsh accretion and loss on Long Island. PhD Thesis, Stony Brook University, Stony Brook, NY.

O'Shea, M. L. and T. M. Brosnan. 2000. Trends in indicators of eutrophication in western Long Island Sound and the Hudson-Raritan Estuary. *Estuaries* 23: 877-901.

Redfield, A. C. 1965. The ontogeny of a salt marsh estuary. *Science* 147: 50-55.

Renwick, W. H. and G. M. Ashley. 1984. Sources, storages and sinks of fine-grained sediment in a fluvial-estuarine system. *Geological Society of America Bulletin* 94: 1343-1348.

Roman, C. T., J. A. Peck, J. R. Allen, J. W. King and P. G. Appleby. 1997. Accretion of a New England (USA) salt marsh in response to inlet migration, storms and sea-level rise. *Estuarine, Coastal and Shelf Science* 45: 7187-727.

Rutgers van der Loeff, M. R., M. M. Sarin, M. Baskaran, C. Benitez-Nelson, K. O. Buesseler, M. Charette, M. Dai, O. Gustafsson, P. Masqué, P. J. Morris, K. Orlandini, A. Rodriguez y Baena, N. Savoye, S. Schmidt, R. Turnewitsch, I. Vöge and J. T. Waples. 2006. A review of present techniques and methodological advances in analyzing ^{234}Th in aquatic systems. *Marine Chemistry* 100: 190-212.

Stumpf, R. P. 1983. The process of sedimentation on the surface of a salt marsh. *Estuarine, Costal and Shelf Science* 17: 495-508.

Suszkowski, D. J. 1978. Sedimentology of Newark Bay, New Jersey: an urban estuary. Ph.D. Thesis, University of Delaware, Newark, DE.

Turekian, K. K., L. K. Benninger and E. P. Dion. 1983. ^{7}Be and ^{210}Pb total depositional fluxes at New Haven, Connecticut, and Bermuda. *Journal of Geophysical Research* 88: 5411-5415.

Appendix A: ^{7}Be distributions in subtidal sediments of Jamaica Bay, NY

Introduction

Beryllium-7 (half-life = 53 d) is produced in the upper troposphere and lower stratosphere through a cosmic-ray spallation reaction of nitrogen and oxygen (Feng et al., 1999a; Ioannidou and Papastefanou, 2006; Kaste et al., 2002). In the troposphere, ^{7}Be adsorbs electrostatically to aerosols and is delivered through wet and dry precipitation to the Earth's surface (Baskaran and Santschi, 1993; Feng, et al., 1999a; Giffen and Corbett, 2003; Kaste et al., 2002). Despite the variations in production within the troposphere and stratosphere, a major control on the ^{7}Be flux to the Earth's surface appears to be delivery through wet precipitation rather than simply production (Turekian et al., 1983). ^{7}Be delivered through wet precipitation to the Earth's surface is in the 2+ valence state (Kaste et al., 2002) and it can be scavenged onto particles in terrestrial (soils) or aquatic (freshwater or marine) environments.

^{7}Be was measured by gamma spectrometry on the same samples taken in Jamaica Bay for ^{234}Th. As the results below show, there is an additional source of ^{7}Be to the bay in association with CSO events. This makes it difficult to use ^{7}Be quantitatively in the same manner as ^{234}Th to quantify sediment dynamics. Nevertheless the temporal patterns of the ^{7}Be distributions provide a qualitative picture of sediment transport in the bay that complements that from ^{234}Th, and we present and discuss the ^{7}Be results in this appendix.

Results and Discussion

^{7}Be Balance in the Subtidal

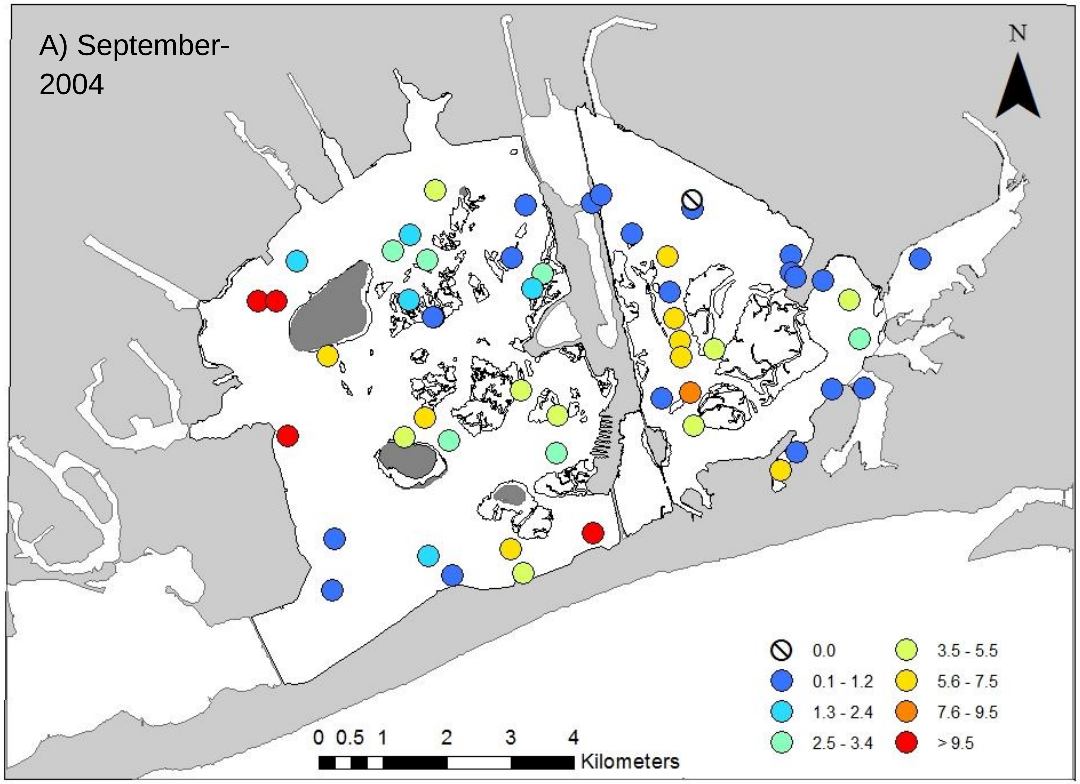
A range of the atmospheric contribution of ^{7}Be into Jamaica Bay was estimated using the correlation between rainfall and ^{7}Be observed in the Chesapeake by Dibb (1989):

$$I_{Be} = 0.0075 \times \text{Rainfall (mm)} + 0.1833 \qquad \text{(A-1)}$$

where I_{Be} is the ^{7}Be inventory (dpm cm^{-2}, or alternatively, the ^{7}Be flux in atoms min^{-1} cm^{-2}) that enters the bay directly from the atmosphere and rainfall is the precipitation in mm that fell in the 53 days prior to sampling. In the 53 days prior to the September-2004, May-2005, November-2005 and July-2006 sampling cruises there were 340, 190, 390, and 220 mm of precipitation, resulting in an estimated 2.7, 1.6, 3.1, and 1.8 dpm cm^{-2} of ^{7}Be entering the bay directly from the atmosphere, respectively. Mean ^{7}Be inventories in the bottom sediments during the September-2004, May-2005, November-2005, and July-2006 cruises were in excess of the estimated ^{7}Be entering the bay directly from the atmosphere prior to sampling (Table A1).

General Patterns of ^{7}Be in Subtidal Sediments

^{7}Be inventories in the surficial bottom sediments are shown in Figure A1a-d. In September-2004 the highest ^{7}Be inventories in the bottom sediments were measured in the northwestern part of the bay, in the southern channel near combined-sewer overflow outfalls, and near the marsh islands in the eastern part of the bay (Figure 3. in the main text and Appendix Figure A1a). In



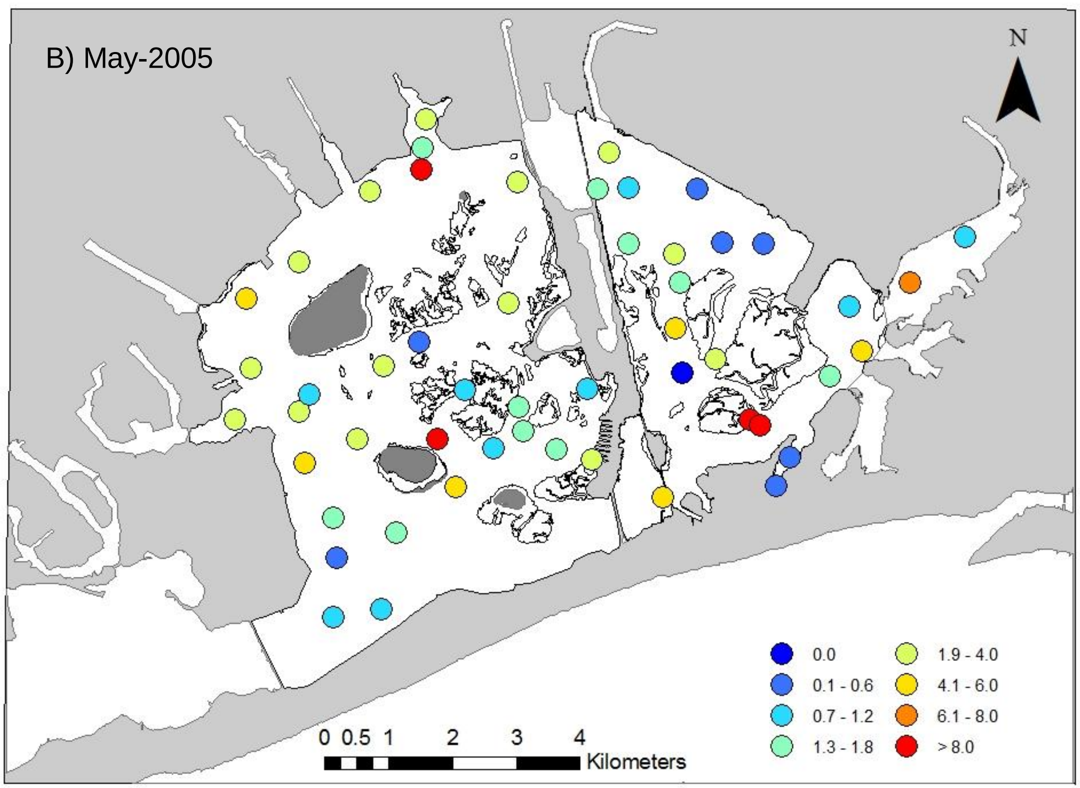
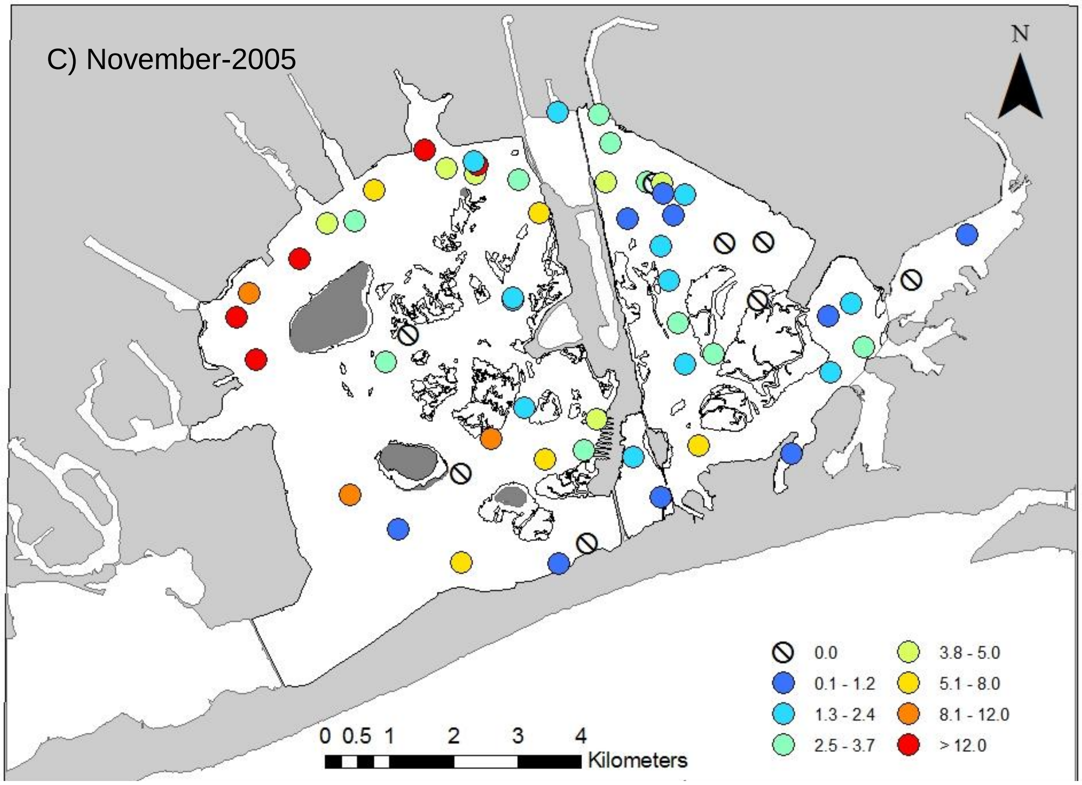


Figure A1. ^{7}Be Inventories of surficial bottom sediments during cruises in a) September-2004, b) May-2005, c) November-2005, d) July-2006. Differences in scale reflect the direct atmospheric input of ^{7}Be. Estimated ^{7}Be inputs from the atmosphere for September-2004, May-2005, November-2005, and July-2006 cruises were 2.7, 1.6, 3.1, and 1.8 dpm cm^{-2}, respectively.



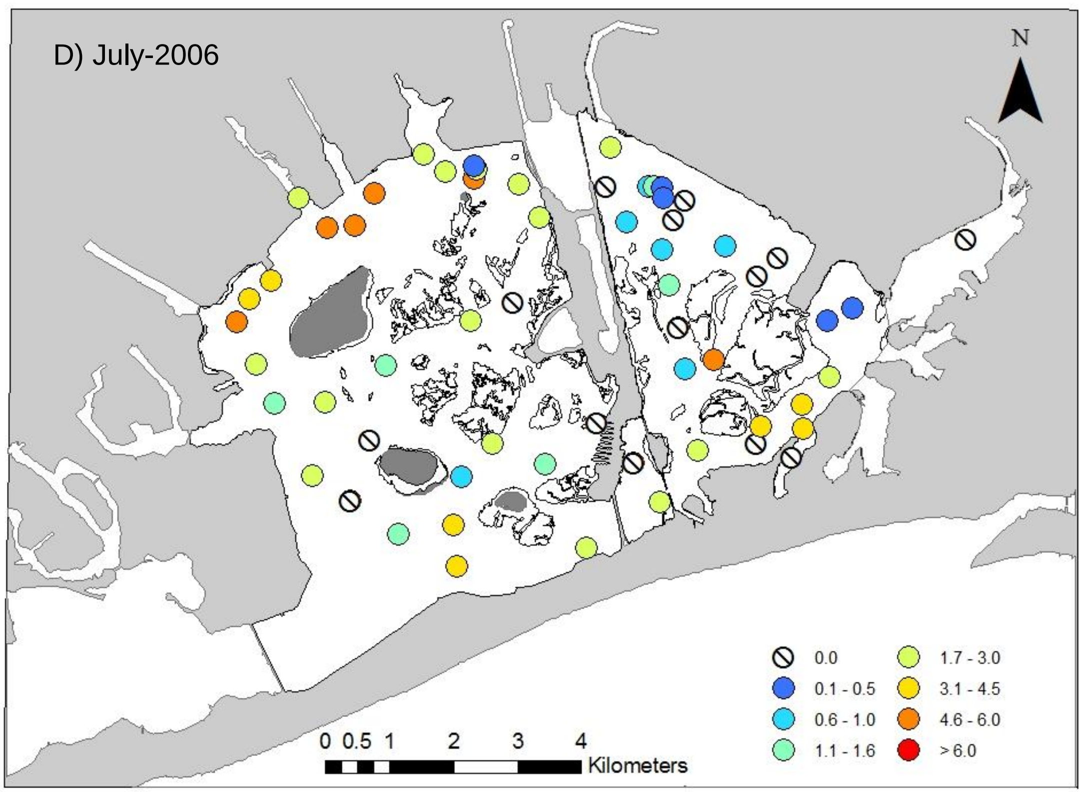


Figure A1. Continued

May-2005 ^{7}Be inventories in the bay sediments were lower than the previous sampling cruise, with the highest inventories located in the eastern part of the bay near JoCo marsh and the western part of the bay near sites of combined-sewer overflow outfall and the 26th Ward waste-water treatment plant (Figure A1b). In November-2005, ^{7}Be inventories were highest in the northwestern part of the bay adjacent to combined-sewer overflow outfall (Figure A1c), in the eastern portion of the bay near the marsh islands, and in Grassy Bay. In July-2006 the highest inventories were found in the northwest near combined-sewer overflow outfall and the 26th Ward treatment plant and in the southeastern channel (Fig. A1d).

Atmospheric Input of ^{7}Be and CSO events

Typically, the dominant source of ^{7}Be into an estuarine system with little riverine input is directly from the atmosphere during rainfall events (Dibb, 1989; Dibb and Rice, 1989). In an idealized estuary, where no lateral transport of water or particles occurs, the ^{7}Be inventory measured in the sediments will likely reflect the atmospheric input, with the only factors causing deviation between the atmospheric input and the bottom sediments being the time required for ^{7}Be to be scavenged on to suspended particle surfaces and then these particles to settle to the bottom. In general, the combination of these factors in many estuaries would actually result in inventories in the bottom sediments that are lower than the direct atmospheric input. Also in most estuaries, lateral transport of water and particles are important and may result in focusing in localized areas where ^{7}Be inventories in the bottom sediments exceed the inventory supported by the direct input. However, in Jamaica Bay the mean ^{7}Be inventories in the surficial bottom sediments during all the sampling cruises were in excess by 40-60% relative to the estimated direct atmospheric input to the bay (Table A1). Rainfall prior to each sampling cruise varied, with the highest rainfall occurring prior to September-2004 and November-2005 sampling cruises (Fig. A2). These results suggest that there is a source of ^{7}Be in addition to direct atmospheric input into Jamaica Bay.

The dominant source of freshwater into Jamaica bay is from wastewater treatment plants (Botton et al., 2006; O'Shea and Brosnan, 2000). There are four primary wastewater treatment plants on the bay – Coney Island, 26th Ward, Jamaica, and Rockaway. During light rainfall events ^{7}Be may be deposited on the impervious surfaces in the bay watershed. During heavy rainfall events the previously deposited ^{7}Be, as well as that supplied from the rain event itself, may be rinsed off of the roads and into the combined sewers. During these heavy rainfall events the waste water treatment plants may become overloaded with water, particularly from street runoff causing the treatment plants to be bypassed, dumping untreated wastewater and storm water, including ^{7}Be, directly in to the bay. This additional source complicates the mass balance of ^{7}Be in Jamaica Bay and diminishes its use as a tracer for sediment transport and deposition in the bay. The pattern of enhanced ^{7}Be supply near CSO outfalls is especially seen in the November-2005 sampling (Fig. A1c). There was a significant storm prior to that sampling that resulted in a CSO event and ^{7}Be input to the bay. The enhanced inventories near the CSO outfalls in the northwestern part of the bay are the result (Fig. A1c).

Table A1. ^{7}Be inventories in subtidal sediments and atmospheric inputs for September-2004, May-2005, November-2005, and July-2006 sampling cruises

	Mean Sediment ^{7}Be Inventory (dpm cm^{-2})	**Direct ^{7}Be flux from atmosphere* (dpm cm^{-2})**	**^{7}Be Inventory /Input****
September-04	3.8 ± 0.6	2.7	1.4
May-05	2.6 ± 0.5	1.6	1.6
November-05	4.1 ± 0.7	3.0	1.4
July-06	2.6 ± 0.3	1.8	1.4

*Calculated using data of Dibb (1989).

** Relative to direct atmospheric input of ^{7}Be.

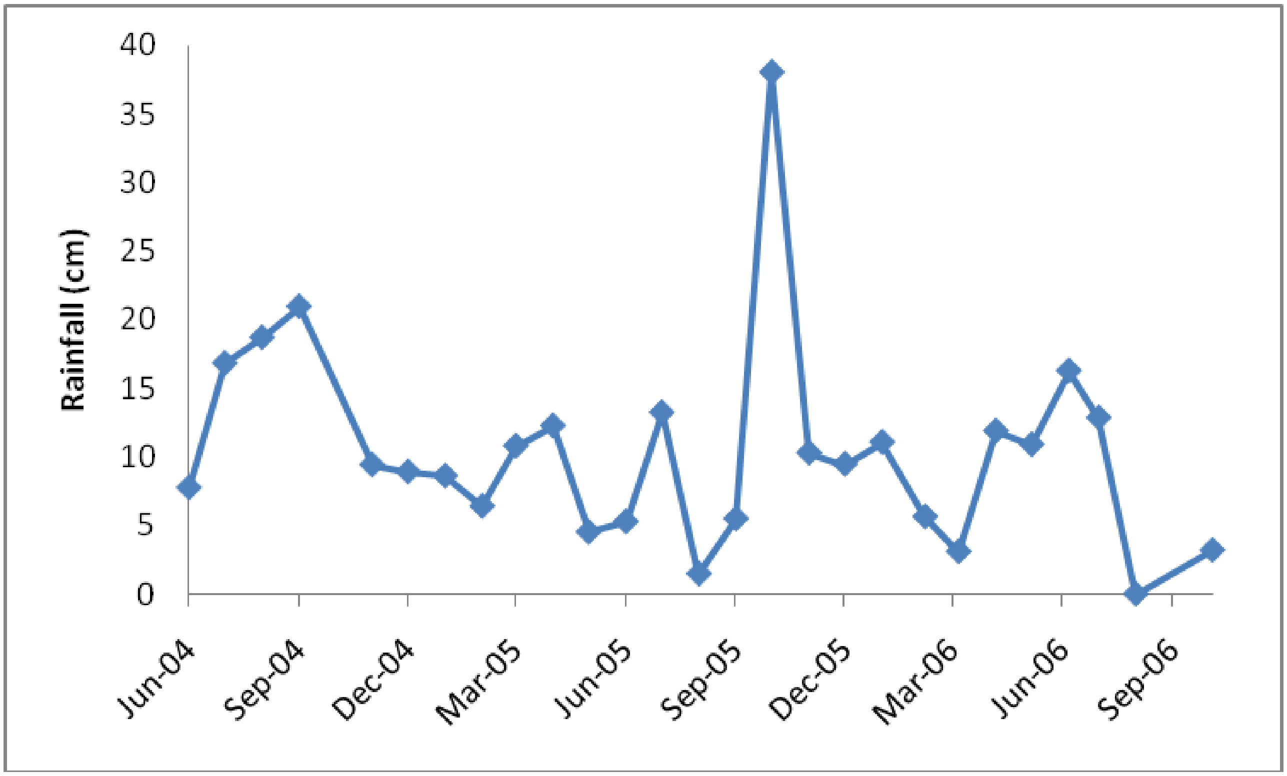


Figure A2. Rainfall observed at New York JFK International Airport from June 2004 to August 2006. Note high rainfall events preceding September-2004 and November-2005 samplings.

Literature Cited

Baskaran, M. and P. H. Santchi. 1993. The role of particles and colloids in the transport of radionuclides in the coastal environments of Texas. *Marine Chemistry* 43: 95-114.

Botton, M. L., R. E. Loveland, J. T. Tanacredi, and T. Itow. 2006. Horseshoe Crabs (*Limulus polyphemus*) in an urban estuary (Jamaica Bay, New York) and the potential for ecological restoration. *Estuaries and Coasts* 29: 820-830.

Dibb, J. E. 1989. Atmospheric deposition of beryllium-7 in the Chesapeake Bay region. *Journal of Geophysical Research* 94: 2261-2265.

Dibb, J. E. and D. L. Rice. 1989. Temporal and spatial distribution of beryllium-7 in the sediments of Chesapeake Bay. *Estuarine, Coastal and Shelf Science* 28: 395-406.

Feng, H., J. K. Cochran and D. J. Hirschberg. 1999. ^{234}Th and ^{7}Be as tracers for the sources of particles to the turbidity maximum of the Hudson River Estuary. *Estuarine, Coastal, and Shelf Science* 49: 629-645.

Giffin, D. and D. R. Corbett. 2003. Evaluation of sediment dynamics in coastal systems via short-lived radioisotopes. *Journal of Marine Systems* 42: 83-96.

Ioannidou, A. and C. Papastefanou. 2006. Precipitation scavenging of ^{7}Be and ^{137}Cs radionuclides in air. *Journal of Environmental Radioactivity* 85:121-136.

Kaste, J. M., S. A. Norton and C. T. Hess. 2002. Environmental chemistry of beryllium-7. Pages 291-312 *in* P. H. Ribbe and J. J. Rosso editors. Beryllium: Mineralogy, petrology, and geochemistry, Reviews in Mineralogy and Geochemistry, vol. 50.

O'Shea, M. L. and T. M. Brosnan. 2000. Trends in indicators of eutrophication in western Long Island Sound and the Hudson-Raritan Estuary. *Estuaries* 23: 877-901.

Turekian, K. K., L. K. Benninger and E. P. Dion. 1983. ^{7}Be and ^{210}Pb total depositional fluxes at New Haven, Connecticut, and Bermuda. *Journal of Geophysical Research* 88: 5411-5415.

Appendix B: Sampling Information and Radionuclide Data Tables

Table B1. September-2004 sample site coordinates, dry bulk density and sediment description.

Sample Date	Sample ID	Latitude (N)	Longitude (W)	Dry Bulk Density (0-5 cm) (g cm^{-3})	Sediment Description
9/16/04	JB9-04-2	40° 37.5498’	73° 49.9669’	1.4	sandy, ulva
9/16/04	JB9-04-3	40° 37.4332’	73° 50.0831’	1.8	silty sand
9/16/04	JB9-04-4	40° 36.5666’	73° 50.2336’	1.8	sand
9/16/04	JB9-04-5	40° 35.2334’	73° 50.3666’	0.6	anoxic mud
9/16/04	JB9-04-6	40° 36.1498’	73° 51.0337’	1.7	sandy hermit crabs
9/16/04	JB9-04-7	40° 36.3502’	73° 49.8331’	1.9	fine sand, grey, hermit
9/16/04	JB9-04-8	40° 36.0330’	73° 49.8500’	1.4	black silty, mud
9/16/04	JB9-04-9	40° 34.8999’	73° 50.2001’	0.4	grey mud
9/16/04	JB9-04-10	40° 34.8999’	73° 50.2001’	1.0	grey mud
9/16/04	JB9-04-11	40° 35.0167’	73° 51.0169’	1.8	grey, silt, fine sand
9/16/04	JB9-04-12	40° 35.1831’	73° 51.2835’	1.9	fine sand, oxic layer
9/16/04	JB9-04-13	40° 34.9001’	73° 52.3503’	2.1	fine/medium sand
9/16/04	JB9-04-14	40° 35.3333’	73° 52.3168’	1.5	fine sand, black
9/16/04	JB9-04-15	40° 36.0497’	73° 51.5665’	2.2	fine sand, shell hash
9/16/04	JB9-04-16	40° 36.3497’	73° 51.2997’	1.2	fine sand, worm tube
9/16/04	JB9-04-17	40° 37.3497’	73° 51.4664’	1.7	fine sand
9/16/04	JB9-04-18	40° 37.1999’	73° 51.1831’	1.8	fine sand
9/16/04	JB9-04-19	40° 37.2000’	73° 51.2001’	1.3	fine sand
9/16/04	JB9-04-20A	40° 36.1668’	73° 53.1502’	0.2	fine mud
9/16/04	JB9-04-20B	40° 36.1668’	73° 53.1502’	0.2	fine mud
9/16/04	JB9-04-21	40° 37.3498’	73° 53.1334’	0.5	fine organic gray mud
9/16/04	JB9-04-22	40° 37.3500’	73° 52.9334’	0.6	reducing mud
9/16/04	JB9-04-22B	40° 37.3500’	73° 52.9334’	0.3	reducing mud
9/16/04	JB-04-23	40° 37.6834’	73° 52.7001’	2.1	fine sand
9/16/04	JB9-04-25	40° 37.9002’	73° 51.4336’	1.6	fine sand
9/16/04	JB9-04-26	40° 38.2665’	73° 51.1499’	1.5	reducing fine sand
9/16/04	JB-04-27A	40° 38.1333’	73° 50.1497’	1.9	reducing mud

Sample Date	Sample ID	Latitude (N)	Longitude (W)	Dry Bulk Density (0-5 cm) (g cm^{-3})	Sediment Description
9/16/04	JB9-04-27C	40° 38.1333'	73° 50.1497'	0.5	reducing mud
9/16/04	JB9-04-29	40° 38.1501'	73° 49.4165'	0.5	reducing mud
9/16/04	JB9-04-30	40° 38.0830'	73° 48.3002'	0.5	reducing mud
9/16/04	JB9-04-31	40° 37.6831'	73° 47.2169'	0.2	reducing mud
9/16/04	JB9-04-32	40° 37.4833'	73° 46.9836'	0.3	reducing mud
9/16/04	JB9-04-33	40° 37.4999'	73° 47.1663'	0.3	reducing mud
9/16/04	JB9-04-33B	40° 37.4999'	73° 47.1663'	1.0	reducing mud
9/16/04	JB9-04-34	40° 37.2997'	73° 46.5833'	0.4	mud
9/16/04	JB9-04-35	40° 36.9665'	73° 46.4667'	1.9	sand
9/17/04	JB9-04-36	40° 36.5500'	73° 46.4332'	2.0	sand
9/17/04	JB9-04-38	40° 25.7330'	73° 46.9837'	2.1	medium sand
9/17/04	JB9-04-39	40° 36.0163'	73° 47.1832'	0.7	reducing mud
9/17/04	JB9-04-40	40° 35.8664'	73° 47.3668'	1.3	sandy, oxidized layer
9/17/04	JB9-04-41	40° 35.8664'	73° 47.3668'	0.7	mud
9/17/04	JB9-04-44	40° 35.3666'	73° 49.2667'	1.8	sand
9/17/04	JB9-04-45	40° 36.8834'	73° 52.3666'	1.9	fine snad
9/17/04	JB9-04-46	40° 37.7665'	73° 51.6331'	1.5	very fine sand
9/17/04	JB9-04-47	40° 37.6832'	73° 51.2500'	1.4	fine sand
9/17/04	JB9-04-48	40° 37.6911'	73° 50.3099'	1.2	reduced silty mud
9/17/04	JB9-04-50	40° 37.8830'	73° 48.9834'	1.7	fine sand
9/17/04	JB9-04-51	40° 37.6833'	73° 48.5833'	1.9	large live clam, mud
9/17/04	JB9-04-52	40° 37.3831'	73° 48.5666'	0.5	redcuing mud
9/17/04	JB9-04-53	40° 37.1664'	73° 48.5166'	0.2	mud
9/17/04	JB9-04-54	40° 36.9664'	73° 48.4669'	0.3	mud
9/17/04	JB9-04-55	40° 36.8333'	73° 48.4501'	0.2	muddy with some shells
9/17/04	JB9-04-56	40° 36.8997'	73° 48.4501'	0.6	silty mud
9/17/04	JB9-04-57	40° 36.2498'	73° 48.3165'	0.5	mud
9/17/04	JB9-04-58	40° 36.4831'	73° 48.6670'	1.0	mud
9/17/04	JB9-04-59	40° 38.2167'	73° 49.3167'	1.6	fine sand
9/17/04	JB9-04-61	40° 36.5333'	73° 48.3498'	0.5	mud
9/17/04	JB9-04-62	40° 37.6333'	73° 45.7834'	0.4	mud

Table B2. September-2004 210Pb activity in subtidal surficial (0-5 cm) samples.

SAMPLE ID	Total ^{210}Pb (dpm g^{-1})	Supported ^{210}Pb (dpm g^{-1})	$^{210}Pb_{xs}$ (dpm g^{-1})
JB9-04-2	2.9 ± 0.1	0.1 ± 0.01	2.8 ± 0.1
JB9-04-3	1.8 ± 0.1	0.8 ± 0.01	1.1 ± 0.1
JB9-04-4	1.5 ± 0.1	0.6 ± 0.01	0.9 ± 0.1
JB9-04-5	5.9 ± 0.3	0.8 ± 0.03	5.1 ± 0.3
JB9-04-6	1.3 ± 0.1	0.5 ± 0.01	0.9 ± 0.1
JB9-04-7	1.5 ± 0.1	0.6 ± 0.01	0.9 ± 0.1
JB9-04-8	2.9 ± 0.1	0.7 ± 0.01	2.2 ± 0.1
JB9-04-9	5.2 ± 0.3	0.7 ± 0.03	4.5 ± 0.3
JB9-04-10	5.0 ± 0.2	0.9 ± 0.02	4.2 ± 0.2
JB9-04-11	1.3 ± 0.1	0.3 ± 0.01	1.0 ± 0.1
JB9-04-12	1.7 ± 0.1	0.8 ± 0.01	0.9 ± 0.1
JB9-04-13	0.3 ± 0.1	0.1 ± 0.01	0.1 ± 0.1
JB9-04-14	3.1 ± 0.1	0.5 ± 0.01	2.5 ± 0.1
JB9-04-15	1.0 ± 0.1	0.3 ± 0.01	0.7 ± 0.1
JB9-04-16	2.7 ± 0.1	1.2 ± 0.02	1.5 ± 0.1
JB9-04-17	1.5 ± 0.1	0.7 ± 0.01	0.8 ± 0.1
JB9-04-18	2.0 ± 0.1	0.8 ± 0.01	1.2 ± 0.1
JB9-04-19	1.3 ± 0.1	0.4 ± 0.01	0.9 ± 0.1
JB9-04-20A	8.9 ± 0.4	0.6 ± 0.04	8.3 ± 0.4
JB9-04-20B	9.1 ± 0.3	0.7 ± 0.04	8.4 ± 0.3
JB9-04-21	8.9 ± 0.3	0.7 ± 0.02	8.2 ± 0.3
JB9-04-22	7.6 ± 0.2	0.7 ± 0.02	6.9 ± 0.2
JB9-04-22B	9.7 ± 0.4	0.9 ± 0.1	8.8 ± 0.4
JB-04-23	0.8 ± 0.1	0.4 ± 0.01	0.4 ± 0.1
JB9-04-25	2.5 ± 0.1	0.9 ± 0.01	1.5 ± 0.1
JB9-04-26	2.9 ± 0.2	0.8 ± 0.01	2.1 ± 0.2
JB-04-27A	1.7 ± 0.1	0.7 ± 0.02	1.0 ± 0.1
JB9-04-27C	6.7 ± 0.2	0.7 ± 0.02	6.0 ± 0.2
JB9-04-29	6.6 ± 0.2	0.7 ± 0.02	6.0 ± 0.2
JB9-04-30	7.6 ± 0.3	0.5 ± 0.02	7.1 ± 0.3

Table B2. Continued.

SAMPLE ID	Total ^{210}Pb (dpm g^{-1})	Supported ^{210}Pb (dpm g^{-1})	$^{210}Pb_{xs}$ (dpm g^{-1})
JB9-04-31	8.2 ± 0.3	0.6 ± 0.04	7.6 ± 0.3
JB9-04-32	8.9 ± 0.4	0.6 ± 0.03	8.2 ± 0.4
JB9-04-33	9.6 ± 0.4	1.7 ± 0.04	7.8 ± 0.4
JB9-04-33B	1.8 ± 0.1	0.2 ± 0.01	1.5 ± 0.1
JB9-04-34	8.2 ± 0.2	0.1 ± 0.1	8.1 ± 0.2
JB9-04-35	2.0 ± 0.1	0.8 ± 0.01	1.2 ± 0.1
JB9-04-36	0.4 ± 0.1	0.2 ± 0.01	0.2 ± 0.1
JB9-04-38	1.8 ± 0.1	0.8 ± 0.01	1.0 ± 0.1
JB9-04-39	4.8 ± 0.2	0.6 ± 0.02	4.2 ± 0.2
JB9-04-40	1.5 ± 0.1	0.5 ± 0.01	1.0 ± 0.1
JB9-04-41	4.8 ± 0.2	0.6 ± 0.02	4.2 ± 0.2
JB9-04-44	0.5 ± 0.1	0.4 ± 0.01	0.2 ± 0.1
JB9-04-45	1.7 ± 0.1	0.6 ± 0.01	1.2 ± 0.1
JB9-04-46	2.6 ± 0.1	1.0 ± 0.02	1.6 ± 0.1
JB9-04-47	2.2 ± 0.1	1.0 ± 0.02	1.1 ± 0.1
JB9-04-48	2.9 ± 0.1	0.7 ± 0.01	2.2 ± 0.1
JB9-04-50	2.0 ± 0.1	0.8 ± 0.01	1.2 ± 0.1
JB9-04-51	1.6 ± 0.1	0.9 ± 0.01	0.7 ± 0.1
JB9-04-52	6.3 ± 0.2	0.5 ± 0.02	5.8 ± 0.2
JB9-04-53	8.3 ± 0.3	0.6 ± 0.03	7.7 ± 0.3
JB9-04-54	5.6 ± 0.3	0.6 ± 0.03	5.0 ± 0.3
JB9-04-55	8.1 ± 0.3	0.7 ± 0.03	7.4 ± 0.3
JB9-04-56	3.5 ± 0.2	1.0 ± 0.02	2.6 ± 0.2
JB9-04-57	8.8 ± 0.3	0.7 ± 0.02	8.1 ± 0.3
JB9-04-58	4.1 ± 0.2	0.7 ± 0.01	3.4 ± 0.2
JB9-04-59	1.3 ± 0.1	0.4 ± 0.01	0.9 ± 0.1
JB9-04-61	6.5 ± 0.3	0.7 ± 0.02	5.7 ± 0.3
JB9-04-62	8.5 ± 0.3	0.6 ± 0.02	7.9 ± 0.3

Table B3. September-2004 234Th activities in subtidal samples.

SAMPLE ID	Total ^{234}Th Activity (dpm g^{-1})	Supported ^{234}Th Activity (dpm g^{-1})	^{234}Th$_{xs}$ Activity (dpm g^{-1})
JB9-04-2	3.4 ± 0.2	2.1 ± 0.2	1.2 ± 0.3
JB9-04-3	2.5 ± 0.2	1.8 ± 0.1	0.6 ± 0.2
JB9-04-4	1.5 ± 0.1	1.5 ± 0.1	0.0 ± 0.1
JB9-04-5	4.5 ± 0.4	1.6 ± 0.2	2.9 ± 0.5
JB9-04-6	1.3 ± 0.2	1.3 ± 0.1	0.0 ± 0.2
JB9-04-7	2.4 ± 0.2	1.5 ± 0.1	0.9 ± 0.2
JB9-04-8	2.7 ± 0.2	1.8 ± 0.2	0.9 ± 0.3
JB9-04-9	2.5 ± 0.3	2.0 ± 0.3	0.5 ± 0.4
JB9-04-10	3.8 ± 0.3	2.1 ± 0.2	1.7 ± 0.3
JB9-04-11	2.0 ± 0.2	1.3 ± 0.1	0.7 ± 0.2
JB9-04-12	3.3 ± 0.2	2.4 ± 0.2	0.9 ± 0.3
JB9-04-13	0.3 ± 0.1	0.3 ± 0.1	0.0 ± 0.1
JB9-04-14	2.3 ± 0.9	1.6 ± 0.1	0.8 ± 0.9
JB9-04-15	2.5 ± 0.3	1.0 ± 0.1	1.5 ± 0.3
JB9-04-16	3.4 ± 0.3	2.0 ± 0.1	1.4 ± 0.3
JB9-04-17	1.8 ± 0.2	1.7 ± 0.1	0.2 ± 0.2
JB9-04-18	3.7 ± 0.2	1.3 ± 0.1	2.4 ± 0.3
JB9-04-19	3.3 ± 0.8	1.0 ± 0.1	2.3 ± 0.8
JB9-04-20A	3.2 ± 0.3	1.2 ± 0.2	2.0 ± 0.3
JB9-04-20B	4.5 ± 0.6	2.4 ± 0.2	2.1 ± 0.6
JB9-04-21	3.1 ± 0.3	1.4 ± 0.1	1.7 ± 0.3
JB9-04-22	3.4 ± 0.3	1.9 ± 0.1	1.5 ± 0.3
JB9-04-22B	10.0 ± 1.2	1.9 ± 0.1	8.1 ± 1.3
JB-04-23	1.5 ± 0.2	1.0 ± 0.1	0.5 ± 0.2
JB9-04-25	2.5 ± 0.2	2.2 ± 0.2	0.3 ± 0.2
JB9-04-26	1.3 ± 0.1	1.6 ± 0.1	-0.3 ± 0.2
JB-04-27A	3.3 ± 0.3	1.3 ± 0.2	2.0 ± 0.4
JB9-04-27C	5.1 ± 0.4	1.9 v 0.2	3.2 ± 0.4
JB9-04-29	2.3 ± 0.2	1.3 ± 0.1	1.0 ± 0.2
JB9-04-30	2.5 ± 0.3	1.2 ± 0.1	1.3 ± 0.3
JB9-04-31	2.5 ± 0.4	1.2 ± 0.2	1.3 ± 0.4
JB9-04-32	3.5 ± 0.3	1.7 ± 0.2	1.8 ± 0.4
JB9-04-33	2.8 ± 0.2	1.5 ± 0.2	1.3 ± 0.3

Table B3. Continued.

SAMPLE ID	Total ^{234}Th Activity (dpm g^{-1})	Supported ^{234}Th Activity (dpm g^{-1})	^{234}Th$_{xs}$ Activity (dpm g^{-1})
JB9-04-33B	1.2 ± 0.1	1.2 ± 0.1	0.0 ± 0.1
JB9-04-34	2.7 ± 0.2	1.8 ± 0.1	0.9 ± 0.2
JB9-04-35	3.6 ± 0.3	1.8 ± 0.2	1.8 ± 0.3
JB9-04-36	0.8 ± 0.1	0.6 ± 0.1	0.2 ± 0.1
JB9-04-38	3.7 ± 0.3	2.3 ± 0.1	1.4 ± 0.3
JB9-04-39	3.4 ± 0.3	1.7 ± 0.1	1.7 ± 0.3
JB9-04-40	2.1 ± 0.2	1.2 ± 0.2	0.9 ± 0.3
JB9-04-41	3.2 ± 0.3	2.0 ± 0.3	1.2 ± 0.4
JB9-04-44	0.8 ± 0.1	0.6 ± 0.1	0.1 ± 0.2
JB9-04-45	2.5 ± 0.3	1.5 ± 0.1	1.0 ± 0.3
JB9-04-46	2.0 ± 0.1	1.7 ± 0.1	0.3 ± 0.2
JB9-04-47	2.4 ± 0.2	2.2 ± 0.2	0.1 ± 0.3
JB9-04-48	3.5 ± 0.2	1.9 ± 0.2	1.6 ± 0.3
JB9-04-50	2.6 ± 0.2	1.9 ± 0.2	0.7 ± 0.3
JB9-04-51	1.8 ± 0.1	1.9 ± 0.1	-0.1 ± 0.2
JB9-04-52	1.4 ± 0.1	1.2 ± 0.1	0.2 ± 0.2
JB9-04-53	3.7 ± 0.4	1.6 ± 0.2	2.1 ± 0.5
JB9-04-54	2.1 ± 0.2	1.2 ± 0.1	0.9 ± 0.3
JB9-04-55	3.8 ± 1.2	1.6 ± 0.1	2.2 ± 1.2
JB9-04-56	2.0 ± 0.2	1.8 ± 0.1	0.2 ± 0.2
JB9-04-57	1.3 ± 0.1	1.1 ± 0.1	0.2 ± 0.1
JB9-04-58	1.8 ± 0.1	1.5 ± 0.1	0.3 ± 0.1
JB9-04-59	3.9 ± 0.2	1.4 ± 0.1	2.5 ± 0.3
JB9-04-61	2.1 ± 0.2	1.0 ± 0.1	1.1 ± 0.2
JB9-04-62	3.0 ± 0.2	1.8 ± 0.1	1.2 ± 0.2

Table B4. September-2004 234Thxs and 7Be inventories in subtidal samples (0-5 cm).

SAMPLE ID	$^{234}Th_{xs}$ Inventory (dpm cm^{-2})	^{7}Be Inventory (dpm cm^{-2})
JB9-04-2	8.4 ± 2.0	2.5 ± 0.5
JB9-04-3	5.8 ± 2.1	1.8 ± 0.6
JB9-04-4	0.0 ± 1.4	5.1 ± 0.5
JB9-04-5	8.0 ± 1.3	7.1 ± 0.8
JB9-04-6	0.0 ± 1.9	3.2 ± 0.5
JB9-04-7	8.5 ± 1.9	4.3 ± 0.6
JB9-04-8	6.2 ± 1.9	3.1 ± 0.5
JB9-04-9	1.0 ± 0.8	4.5 ± 0.3
JB9-04-10	8.5 ± 1.6	15.7 ± 0.8
JB9-04-11	6.3 ± 1.9	1.0 ± 0.5
JB9-04-12	8.4 ± 2.8	2.1 ± 0.7
JB9-04-13	0.0 ± 1.2	0.4 ± 0.3
JB9-04-14	5.7 ± 6.5	0.0 ± 0.0
JB9-04-15B	16.8 ± 3.0	0.4 ± 0.5
JB9-04-16	8.1 ± 1.8	7.1 ± 0.8
JB9-04-17	0.0 ± 1.9	2.0 ± 0.7
JB9-04-18B	21.7 ± 2.5	3.4 ± 0.6
JB9-04-19	14.9 ± 5.0	0.0 ± 0.0
JB9-04-20A	1.7 ± 0.3	9.9 ± 0.5
JB9-04-20B	2.4 ± 0.7	7.1 ± 0.6
JB9-04-21	4.2 ± 0.8	25.8 ± 0.9
JB9-04-22	4.3 ± 0.9	5.8 ± 0.6
JB9-04-22B	13.2 ± 2.9	19.2 ± 1.5
JB-04-23	5.2 ± 1.9	1.8 ± 0.8
JB9-04-25	0.0 ± 1.8	2.0 ± 0.5
JB9-04-26	0.0 ± 1.1	4.7 ± 0.5
JB-04-27A	19.4 ± 3.9	0.6 ± 1.0
JB9-04-27C	8.3 ± 1.1	8.7 ± 0.6
JB9-04-29C	2.2 ± 0.4	0.9 ± 0.3
JB9-04-30	3.1 ± 0.7	0.3 ± 0.3
JB9-04-31	1.2 ± 0.4	0.0 ± 0.0
JB9-04-32	2.4 ± 0.5	0.0 ± 0.0
JB9-04-33	2.1 ± 0.5	0.1 ± 0.3
JB9-04-33B	0.0 ± 0.7	0.5 ± 0.3

Table B4. Continued.

SAMPLE ID	$^{234}Th_{xs}$ Inventory (dpm cm^{-2})	^{7}Be Inventory (dpm cm^{-2})
JB9-04-34	1.8 ± 0.4	3.9 ± 0.4
JB9-04-35	16.7 ± 3.0	2.7 ± 1.2
JB9-04-36	0.0 ± 1.3	0.1 ± 0.4
JB9-04-38	14.5 ± 2.9	0.5 ± 0.6
JB9-04-39	5.5 ± 1.0	0.7 ± 0.6
JB9-04-40	6.3 ± 1.9	1.0 ± 0.4
JB9-04-41	4.0 ± 1.5	6.3 ± 0.6
JB9-04-44	0.0 ± 1.4	0.0 ± 0.0
JB9-04-45	9.7 ± 3.3	5.6 ± 0.7
JB9-04-46	0.0 ± 1.4	2.7 ± 0.6
JB9-04-47	0.0 ± 1.8	2.8 ± 0.5
JB9-04-48	9.6 ± 1.7	0.3 ± 0.5
JB9-04-50	5.8 ± 2.1	0.5 ± 0.5
JB9-04-51	0.0 ± 1.6	6.0 ± 0.6
JB9-04-52	0.0 ± 0.4	0.4 ± 0.1
JB9-04-53	2.4 ± 0.5	6.4 ± 0.6
JB9-04-54	1.4 ± 0.4	7.4 ± 0.5
JB9-04-55	2.7 ± 1.5	6.8 ± 0.5
JB9-04-56	0.0 ± 0.7	4.2 ± 0.4
JB9-04-57	0.0 ± 0.3	5.4 ± 0.4
JB9-04-58	0.0 ± 0.7	0.1 ± 0.3
JB9-04-59	19.6 ± 2.3	0.9 ± 0.4
JB9-04-61	2.6 ± 0.5	7.9 ± 0.5
JB9-04-62	2.7 ± 0.5	0.2 ± 0.3

Table B5. May-2005 sample site coordinates, dry bulk density and sediment description.

Sample Date	Sample ID	Latitude (N)	Longitude (W)	Dry Bulk Density (0-5 cm) (g cm^{-3})	Sediment Description
5/19/2005	JB5-05-1	40°37.3483´	73° 50.3513´	0.2	organic mud
5/19/2005	JB5-05-2	40° 38.3644´	73° 50.2365´	1.5	muddy sand
5/19/2005	JB5-05-3	40° 38.9117´	73° 51.2404´	0.6	very fluffy mud
5/19/2005	JB5-05-4	40° 38.6673´	73° 51.2814´	1.1	silty mud
5/19/2005	JB5-05-5	40° 38.4809´	73° 51.2967´	0.3	mud
5/19/2005	JB5-05-6	40° 38.3083´	73° 51.8786´	0.8	fluffy mud
5/19/2005	JB5-05-7	40° 37.7140´	73° 52.6740´	1.1	muddy sand
5/19/2005	JB5-05-8	40° 37.4104´	73° 53.2537´	1.1	mud
5/19/2005	JB5-05-9	40° 38.6097´	73° 49.2168´	0.3	reducing mud
5/19/2005	JB5-05-10	40° 38.3003´	73° 49.3485´	1.5	fine silty sand
5/19/2005	JB5-05-11	40° 38.3071´	73° 49.0086´	0.2	fluffy mud
5/19/2005	JB5-05-12	40° 38.2900´	73° 48.2454´	0.2	mud
5/19/2005	JB5-05-13	40° 37.8299´	73° 47.9720´	0.2	anoxic mud
5/19/2005	JB5-05-14	40° 37.8165´	73° 47.5217´	0.4	mud
5/19/2005	JB5-05-16	40° 37.7419´	73° 48.5077´	0.6	mud
5/19/2005	JB5-05-17	40° 37.8363´	73° 49.0126´	1.5	Sand
5/19/2005	JB5-05-18	40° 37.4987´	73° 48.4511´	0.4	fluffy mud
5/19/2005	JB5-05-19	40° 37.1128´	73° 48.5104´	0.3	fluffy mud
5/19/2005	JB5-05-20	40° 36.7342´	73° 48.4349´	0.3	mud
5/19/2005	JB5-05-21	40° 36.3352´	73° 47.6966´	1.5	mud
5/19/2005	JB5-05-22	40° 36.8498´	73° 48.0661´	0.5	mud
5/19/2005	JB5-05-23	40° 35.6860´	73° 48.6790´	1.6	mud
5/19/2005	JB5-05-24	40° 36.2800´	73° 47.5912´	0.6	mud
5/19/2005	JB5-05-25	40° 36.6912´	73° 46.8058´	0.7	fluffy mud
5/19/2005	JB5-05-26	40° 37.2802´	73° 46.5837´	0.5	fluffy mud
5/19/2005	JB5-05-27	40° 36.8982´	73° 46.4488´	0.7	fluffy mud
5/19/2005	JB5-05-28	40° 37.4745´	73° 45.8991´	1.0	sandy mud
5/19/2005	JB5-05-29	40° 37.8571´	73° 45.2855´	0.5	mud
5/20/2005	JB5-05-30	40° 36.8182´	73° 53.2146´	0.6	mud
5/20/2005	JB5-05-31	40° 36.3891´	73° 53.3983´	0.3	organic mud

Table B5. Continued.

Sample Date	Sample ID	Latitude (N)	Longitude (W)	Dry Bulk Density (0-5 cm) (g cm^{-3})	Sediment Description
5/20/2005	JB5-05-32	40° 36.4461´	73° 52.6889´	0.6	mud
5/20/2005	JB5-05-33	40° 36.5973´	73° 52.5700´	1.5	silty sand
5/20/2005	JB5-05-34	40° 36.0185´	73° 52.6329´	0.8	reducing mud
5/20/2005	JB5-05-35	40° 35.5523´	73° 52.3237´	0.7	silty mud
5/20/2005	JB5-05-36	40° 36.2166´	73° 52.0502´	1.6	mud
5/20/2005	JB5-05-37	40° 36.8265´	73° 51.7441´	1.4	sand
5/20/2005	JB5-05-38	40° 37.0221´	73° 51.3564´	1.5	sand
5/20/2005	JB5-05-39	40° 35.2055´	73° 52.2963´	1.6	sand
5/20/2005	JB5-05-40	40° 34.7055´	73° 52.3422´	1.8	sand
5/20/2005	JB5-05-41	40° 34.7716´	73° 51.8080´	0.7	organic mud
5/20/2005	JB5-05-43	40° 35.4141´	73° 51.6277´	0.4	sand
5/23/2005	JB5-05-47	40° 35.7995´	73° 50.9730´	0.4	mud
5/23/2005	JB5-05-48	40° 36.1986´	73° 51.1612´	1.6	silty sand
5/23/2005	JB5-05-50	40° 36.6144´	73° 50.8484´	1.6	silty sand
5/23/2005	JB5-05-51	40° 36.4685´	73° 50.2637´	0.7	sandy mud
5/23/2005	JB5-05-52	40° 36.2653´	73° 50.2076´	0.8	silty sand
5/23/2005	JB5-05-53	40° 36.1027´	73° 49.8445´	1.4	silty sand
5/23/2005	JB5-05-54	40° 36.0090´	73° 49.4483´	0.3	mud
5/23/2005	JB5-05-55	40° 36.6105´	73° 49.4931´	0.4	mud
5/23/2005	JB5-05-56	40° 36.1221´	73° 50.5370´	1.6	sand
5/23/2005	JB5-05-57	40° 36.0091´	73° 47.2649´	0.2	mud
5/23/2005	JB5-05-58	40° 35.7718´	73° 47.4210´	0.3	mud

Table B6. May-2005 ^{210}Pb activities in subtidal samples.

Sample ID	Total ^{210}Pb (dpm g^{-1})	Supported ^{210}Pb (dpm g^{-1})	^{210}Pb$_{xs}$ (dpm g^{-1})
JB5-05-1	6.6 ± 0.4	3.0 ± 0.1	3.6 ± 0.4
JB5-05-2	1.4 ± 0.1	1.4 ± 0.03	0.0 ± 0.1
JB5-05-3	4.9 ± 0.2	2.1 ± 0.05	2.8 ± 0.2
JB5-05-4	4.8 ± 0.3	0.0 ± 0.0	4.8 ± 0.3
JB5-05-5	6.8 ± 0.2	2.1 ± 0.1	4.7 ± 0.3
JB5-05-6	3.0 ± 0.1	0.8 ± 0.03	2.1 ± 0.1
JB5-05-7	2.3 ± 0.1	1.3 ± 0.03	0.9 ± 0.1
JB5-05-8	6.8 ± 0.2	1.8 ± 0.05	5.0 ± 0.2
JB5-05-9	7.2 ± 0.2	1.9 ± 0.1	5.3 ± 0.3
JB5-05-10	1.2 ± 0.1	0.8 ± 0.02	0.4 ± 0.1
JB5-05-11	7.4 ± 0.3	1.5 ± 0.1	5.9 ± 0.3
JB5-05-12	9.1 ± 0.3	1.5 ± 0.1	7.6 ± 0.3
JB5-05-13	8.8 ± 0.3	1.6 ± 0.1	7.2 ± 0.3
JB5-05-14	5.0 ± 0.2	1.1 ± 0.1	3.9 ± 0.3
JB5-05-16	7.3 ± 0.3	1.5 ± 0.1	5.8 ± 0.3
JB5-05-17	3.2 ± 0.2	3.5 ± 0.04	-0.3 ± 0.2
JB5-05-18	6.7 ± 0.2	1.5 ± 0.1	5.2 ± 0.2
JB5-05-19	6.7 ± 0.3	2.3 ± 0.1	4.3 ± 0.3
JB5-05-20	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0
JB5-05-21	9.0 ± 0.3	2.1 ± 0.1	6.9 ± 0.3
JB5-05-22	3.7 ± 0.2	3.9 ± 0.1	-0.2 ± 0.2
JB5-05-23	0.4 ± 0.1	0.4 ± 0.02	0.0 ± 0.1
JB5-05-24	9.0 ± 0.4	1.9 ± 0.1	7.2 ± 0.4
JB5-05-25	8.1 ± 0.3	2.2 ± 0.1	5.9 ± 0.3
JB5-05-26	8.1 ± 0.2	1.4 ± 0.1	6.7 ± 0.2
JB5-05-27	4.4 ± 0.2	1.6 ± 0.05	2.8 ± 0.2
JB5-05-28	3.6 ± 0.2	0.7 ± 0.03	2.9 ± 0.2
JB5-05-29	5.7 ± 0.2	1.1 ± 0.04	4.6 ± 0.2
JB5-05-30	7.1 ± 0.2	1.7 ± 0.05	5.4 ± 0.2
JB5-05-31	9.5 ± 0.3	1.9 ± 0.1	7.6 ± 0.3
JB5-05-32	5.5 ± 0.2	1.9 ± 0.1	3.6 ± 0.2
JB5-05-33	1.7 ± 0.1	1.7 ± 0.03	0.0 ± 0.1
JB5-05-34	7.7 ± 0.3	2.1 ± 0.1	5.6 ± 0.3
JB5-05-35	4.5 ± 0.2	1.9 ± 0.05	2.6 ± 0.2

Table B6. Continued.

Sample ID	Total ^{210}Pb (dpm g^{-1})	Supported ^{210}Pb (dpm g^{-1})	$^{210}Pb_{xs}$ (dpm g^{-1})
JB5-05-36	2.4 ± 0.1	2.7 ± 0.04	-0.3 ± 0.1
JB5-05-37	2.6 ± 0.2	2.9 ± 0.1	-0.3 ± 0.2
JB5-05-38	1.3 ± 0.1	1.5 ± 0.03	-0.2 ± 0.1
JB5-05-39	0.6 ± 0.1	0.8 ± 0.02	-0.2 ± 0.1
JB5-05-40	3.4 ± 0.1	1.0 ± 0.02	2.4 ± 0.1
JB5-05-41	12.2 ± 0.5	10.6 ± 0.1	1.6 ± 0.5
JB5-05-43	1.9 ± 0.2	2.2 ± 0.1	-0.3 ± 0.2
JB5-05-47	5.5 ± 0.2	2.2 ± 0.1	3.4 ± 0.2
JB5-05-48	3.4 ± 0.1	0.7 ± 0.02	2.7 ± 0.1
JB5-05-50	1.4 ± 0.1	1.3 ± 0.02	0.1 ± 0.1
JB5-05-51	3.7 ± 0.2	2.2 ± 0.04	1.5 ± 0.2
JB5-05-52	1.2 ± 0.1	1.2 ± 0.03	0.0 ± 0.1
JB5-05-53	3.4 ± 0.2	3.3 ± 0.04	0.1 ± 0.2
JB5-05-54	7.5 ± 0.3	2.0 ± 0.1	5.5 ± 0.3
JB5-05-55	7.8 ± 0.3	2.1 ± 0.1	5.7 ± 0.3
JB5-05-56	3.1 ± 0.2	2.4 ± 0.03	0.7 ± 0.2
JB5-05-57	8.8 ± 0.3	1.8 ± 0.1	7.0 ± 0.3
JB5-05-58	9.8 ± 0.4	1.5 ± 0.1	8.2 ± 0.4

Table B7. May-2005 234Th activities in subtidal sediments.

SAMPLE ID	Total ^{234}Th (dpm g^{-1})	Supported ^{234}Th (dpm g^{-1})	^{234}Th$_{xs}$ (dpm g^{-1})
JB5-05-1	1.1 ± 0.1	1.0 ± 0.2	0.1 ± 0.2
JB5-05-2	1.2 ± 0.1	1.1 ± 0.1	0.1 ± 0.1
JB5-05-3	2.7 ± 0.1	1.2 ± 0.1	1.5 ± 0.1
JB5-05-4	3.0 ± 0.3	2.0 ± 0.2	1.0 ± 0.3
JB5-05-5	3.6 ± 0.4	2.1 ± 0.2	1.6 ± 0.4
JB5-05-6	2.0 ± 0.2	1.7 ± 0.2	0.3 ± 0.3
JB5-05-7	1.5 ± 0.1	0.7 ± 0.1	0.8 ± 0.2
JB5-05-8	3.2 ± 0.3	2.3 ± 0.2	0.8 ± 0.4
JB5-05-9	2.5 ± 0.3	2.0 ± 0.1	0.5 ± 0.3
JB5-05-10	0.9 ± 0.1	0.8 ± 0.1	0.1 ± 0.2
JB5-05-11	1.6 ± 0.6	1.6 ± 0.1	0.0 ± 0.6
JB5-05-12	2.0 ± 0.3	2.0 ± 0.3	0.0 ± 0.4
JB5-05-13	1.8 ± 0.2	1.8 ± 0.2	0.0 ± 0.3
JB5-05-14	2.4 ± 0.5	1.8 ± 0.1	0.6 ± 0.5
JB5-05-16	3.6 ± 0.3	2.2 ± 0.2	1.4 ± 0.4
JB5-05-17	3.2 ± 0.3	2.2 ± 0.1	1.0 ± 0.4
JB5-05-18	2.9 ± 0.3	2.0 ± 0.2	0.9 ± 0.4
JB5-05-19	4.4 ± 0.5	1.8 ± 0.2	2.6 ± 0.6
JB5-05-20	2.9 ± 0.3	1.8 ± 0.1	1.1 ± 0.3
JB5-05-21	1.9 ± 0.2	1.8 ± 0.2	0.1 ± 0.3
JB5-05-22	2.4 ± 0.2	1.8 ± 0.2	0.6 ± 0.2
JB5-05-23	0.3 ± 0.1	0.3 ± 0.1	0.0 ± 0.1
JB5-05-24	2.9 ± 0.3	1.4 ± 0.1	1.5 ± 0.3
JB5-05-25	1.3 ± 0.1	1.3 ± 0.1	0.0 ± 0.2
JB5-05-26	2.0 ± 0.2	1.2 ± 0.1	0.8 ± 0.2
JB5-05-27	3.5 ± 0.3	2.0 ± 0.1	1.4 ± 0.3
JB5-05-28	2.5 ± 0.3	1.3 ± 0.1	1.2 ± 0.3
JB5-05-29	1.9 ± 0.1	1.5 ± 0.1	0.4 ± 0.2
JB5-05-30	2.0 ± 0.3	1.4 ± 0.1	0.6 ± 0.3
JB5-05-31	3.5 ± 0.6	1.5 ± 0.2	2.0 ± 0.6
JB5-05-32	3.6 ± 0.3	2.0 ± 0.1	1.6 ± 0.4
JB5-05-33	2.6 ± 0.3	2.1 ± 0.1	0.5 ± 0.3
JB5-05-34	4.1 ± 0.4	2.3 ± 0.2	1.8 ± 0.4
JB5-05-35	3.3 ± 0.3	1.6 ± 0.1	1.6 ± 0.3

Table B7. Continued.

SAMPLE ID	Total ^{234}Th (dpm g^{-1})	Supported ^{234}Th (dpm g^{-1})	$^{234}Th_{xs}$ (dpm g^{-1})
JB5-05-37	2.8 ± 0.3	1.8 ± 0.2	1.0 ± 0.3
JB5-05-38	1.7 ± 0.2	1.0 ± 0.1	0.7 ± 0.2
JB5-05-39	1.1 ± 0.2	0.5 ± 0.1	0.6 ± 0.2
JB5-05-40	0.9 ± 0.1	0.4 ± 0.1	0.5 ± 0.1
JB5-05-41	2.2 ± 0.6	1.3 ± 0.05	0.9 ± 0.6
JB5-05-43	1.5 ± 0.2	1.5 ± 0.1	0.0 ± 0.3
JB5-05-47	4.0 ± 0.4	1.4 ± 0.1	2.6 ± 0.4
JB5-05-48	1.3 ± 0.2	0.6 ± 0.04	0.7 ± 0.2
JB5-05-50	1.9 ± 0.2	1.1 ± 0.1	0.7 ± 0.2
JB5-05-51	2.8 ± 0.3	1.5 ± 0.1	1.3 ± 0.3
JB5-05-52	2.7 ± 0.3	1.7 ± 0.2	1.0 ± 0.3
JB5-05-53	2.4 ± 0.2	1.5 ± 0.1	0.9 ± 0.2
JB5-05-54	3.5 ± 0.4	1.6 ± 0.1	1.9 ± 0.5
JB5-05-55	4.5 ± 0.5	2.0 ± 0.1	2.5 ± 0.5
JB5-05-56	1.5 ± 0.3	0.6 ± 0.1	0.9 ± 0.3
JB5-05-57	9.3 ± 1.1	1.8 ± 0.2	7.5 ± 1.1
JB5-05-58	6.0 ± 0.7	1.4 ± 0.1	4.6 ± 0.8

Table B8. May-2005 $^{234}Th_{xs}$ and ^{7}Be inventories in subtidal samples.

SAMPLE ID	$^{234}Th_{xs}$ Inventory (dpm cm^{-2})	^{7}Be Inventory (dpm cm^{-2})
JB5-05-1	0.0 ± 0.2	3.7 ± 0.3
JB5-05-2	0.0 ± 1.1	4.0 ± 0.9
JB5-05-3	4.2 ± 0.4	2.2 ± 0.2
JB5-05-4	5.2 ± 1.6	1.5 ± 0.4
JB5-05-5	2.1 ± 0.6	9.5 ± 0.5
JB5-05-6	0.0 ± 1.1	2.4 ± 0.3
JB5-05-7	4.2 ± 1.0	2.8 ± 0.4
JB5-05-8	4.6 ± 2.0	4.8 ± 0.6
JB5-05-9	0.7 ± 0.4	2.5 ± 0.3
JB5-05-10	0.0 ± 1.1	1.4 ± 0.3
JB5-05-11	0.0 ± 0.7	0.9 ± 0.2
JB5-05-12	0.0 ± 0.5	0.2 ± 0.4
JB5-05-13	0.0 ± 0.3	0.2 ± 0.2
JB5-05-14	1.0 ± 0.9	0.6 ± 0.4
JB5-05-16	3.9 ± 1.1	2.6 ± 0.8
JB5-05-17	7.6 ± 2.8	1.5 ± 0.9
JB5-05-18	1.6 ± 0.7	1.5 ± 0.3
JB5-05-19	4.0 ± 0.8	4.6 ± 0.5
JB5-05-20	1.7 ± 0.5	0.0 ± 0.0
JB5-05-21	0.0 ± 1.9	12.0 ± 2.0
JB5-05-22	1.4 ± 0.5	1.9 ± 0.4
JB5-05-23	0.0 ± 1.0	4.9 ± 0.7
JB5-05-24	4.4 ± 1.0	9.7 ± 1.0
JB5-05-25	0.0 ± 0.6	1.7 ± 0.2
JB5-05-26	2.1 ± 0.6	1.2 ± 0.5
JB5-05-27	5.2 ± 1.0	4.9 ± 0.4
JB5-05-28	5.9 ± 1.4	5.2 ± 0.6
JB5-05-29	1.1 ± 0.4	0.9 ± 0.3
JB5-05-30	1.8 ± 0.8	2.9 ± 0.4
JB5-05-31	2.8 ± 0.8	3.2 ± 0.4
JB5-05-32	5.0 ± 1.1	2.4 ± 0.3
JB5-05-33	4.0 ± 2.3	1.2 ± 0.3
JB5-05-34	6.8 ± 1.7	4.8 ± 0.9
JB5-05-35	5.8 ± 1.1	1.8 ± 0.3

Table B8. Continued.

SAMPLE ID	$^{234}Th_{xs}$ Inventory (dpm cm^{-2})	^{7}Be Inventory (dpm cm^{-2})
JB5-05-36	3.8 ± 1.7	3.0 ± 0.7
JB5-05-37	6.9 ± 2.3	3.1 ± 0.9
JB5-05-38	5.3 ± 1.3	0.5 ± 0.2
JB5-05-39	5.2 ± 1.9	0.3 ± 0.3
JB5-05-40	5.0 ± 1.1	1.1 ± 0.6
JB5-05-41	3.2 ± 2.0	1.0 ± 0.3
JB5-05-43	0.0 ± 0.5	1.5 ± 0.3
JB5-05-47	5.2 ± 0.8	4.0 ± 0.5
JB5-05-48	5.5 ± 1.3	5.2 ± 0.5
JB5-05-50	5.9 ± 1.5	1.0 ± 0.3
JB5-05-51	4.6 ± 0.9	1.7 ± 0.4
JB5-05-52	4.2 ± 1.4	1.8 ± 0.3
JB5-05-53	5.9 ± 1.2	1.4 ± 0.3
JB5-05-54	3.2 ± 0.8	3.2 ± 0.3
JB5-05-55	4.9 ± 0.9	0.9 ± 0.4
JB5-05-56	7.0 ± 2.2	0.8 ± 0.4
JB5-05-57	9.0 ± 1.3	0.6 ± 0.5
JB5-05-58	7.0 ± 1.1	0.3 ± 0.7

Table B9. November-2005 sample site coordinates, dry bulk density and sediment description.

Sample Date	Sample ID	Latitude (N)	Longitude (W)	Dry Bulk Density (0-5 cm) (g cm^{-3})	Sediment Description
11/8/2005	JB11-05-1	40° 36.8712’	73° 53.1669’	0.77	organic mud
11/8/2005	JB11-05-5	40° 37.2278’	73° 53.3766’	0.72	organic mud
11/8/2005	JB11-05-6	40° 37.4276’	73° 53.3766’	0.59	organic mud
11/8/2005	JB11-05-7	40° 37.7139’	73° 52.6726’	0.99	fluffy mud
11/8/2005	JB11-05-8	40° 38.0093’	73° 52.3661’	0.70	fluffy mud
11/8/2005	JB11-05-9	40° 38.0263’	73° 52.0523’	1.20	sandy mud
11/8/2005	JB11-05-10	40° 38.2885’	73° 51.8399’	0.74	fluffy mud
11/8/2005	JB11-05-11	40° 38.6218’	73° 51.2794’	0.58	fluffy mud
11/8/2005	JB11-05-12	40° 38.4659’	73° 51.0358’	0.73	organic mud
11/8/2005	JB11-05-14	40° 38.4130’	73° 50.7181’	0.61	fluffy mud
11/8/2005	JB11-05-15	40° 38.4847’	73° 50.6949’	0.49	fluffy mud
11/8/2005	JB11-05-16	40° 38.5169’	73° 50.7305’	1.71	sand
11/8/2005	JB11-05-17	40° 38.3601’	73° 50.2387’	1.24	fluffy mud
11/8/2005	JB11-05-18	40° 38.0747’	73° 50.0201’	0.59	fluffy mud
11/8/2005	JB11-05-19	40° 37.3485’	73° 50.3130’	1.76	silty sand
11/8/2005	JB11-05-20	40° 37.3594’	73° 50.3241’	1.77	sand
11/8/2005	JB11-05-21	40° 37.0655’	73° 51.4805’	1.75	sand
11/8/2005	JB11-05-22	40° 36.8345’	73° 51.7291’	1.71	sand
11/8/2005	JB11-05-23	40° 35.7213’	73° 52.1472’	0.54	organic mud
11/8/2005	JB11-05-24	40° 35.4259’	73° 51.6211’	0.82	organic mud
11/8/2005	JB11-05-25	40° 35.4299’	73° 51.0418’	1.96	sand
11/8/2005	JB11-05-26	40° 35.8875’	73° 50.9112’	1.66	sand
11/8/2005	JB11-05-27	40° 36.1787’	73° 50.5772’	0.73	fluffy mud
11/8/2005	JB11-05-28	40° 36.4350’	73° 50.2082’	1.67	sand
11/8/2005	JB11-05-29	40° 35.9988’	73° 49.9931’	0.75	fluffy mud
11/8/2005	JB11-05-30	40° 36.0695’	73° 49.5537’	0.64	organic mud
11/8/2005	JB11-05-31	40° 36.3313’	73° 49.4157’	0.52	organic mud
11/8/2005	JB11-05-32	40° 35.1396’	73° 50.9319’	1.30	muddy silt
11/8/2005	JB11-05-33	40° 35.1212’	73° 49.8524’	1.63	sand with shell hash
11/8/2005	JB11-05-34	40° 35.2921’	73° 49.5368’	1.78	sand with shell hash

Table B9. Continued.

Sample Date	Sample ID	Latitude (N)	Longitude (W)	Dry Bulk Density (0-5 cm) (g cm^{-3})	Sediment Description
11/8/2005	JB11-05-35A	40° 38.9199’	73° 49.7989’	0.63	organic mud
11/8/2005	JB11-05-35B	40° 38.9199’	73° 49.7989’	0.65	organic mud
11/8/2005	JB11-05-35C	40° 38.9199’	73° 49.7989’	0.64	organic mud
11/8/2005	JB11-05-38	40° 38.6572’	73° 49.2131’	0.54	organic mud
11/8/2005	JB11-05-39	40° 38.3276’	73° 49.2700’	0.45	fluffy mud
11/8/2005	JB11-05-40	40° 38.0134’	73° 40.0421’	0.49	fluffy mud
11/8/2005	JB11-05-41	40° 38.3213’	73° 48.8139’	0.56	fluffy mud
11/19/2005	JB11-05-42	40° 38.3162’	73° 48.7416’	0.64	fluffy mud
11/19/2005	JB11-05-43	40° 38.3175’	73° 48.6557’	0.53	fluffy mud
11/19/2005	JB11-05-44	40° 38.2309’	73° 48.6473’	0.53	fluffy mud
11/19/2005	JB11-05-45	40° 38.2117’	73° 48.4064’	0.52	fluffy mud
11/19/2005	JB11-05-46	40° 38.0389’	73° 48.5259’	0.52	fluffy mud
11/19/2005	JB11-05-47	40° 37.8123’	73° 47.5310’	0.18	fluffy mud
11/19/2005	JB11-05-48	40° 37.3163’	73° 47.5995’	0.20	fluffy mud
11/19/2005	JB11-05-49	40° 37.8077’	73° 47.9660’	0.20	fluffy mud
11/19/2005	JB11-05-50	40° 37.7847’	73° 48.6702’	0.57	silty mud
11/8/2005	JB11-05-51	40° 37.4872’	73° 48.5953’	0.25	fluffy mud
11/8/2005	JB11-05-52	40° 37.1289’	73° 48.5009’	0.20	fluffy mud
11/8/2005	JB11-05-53	40° 36.8644’	73° 48.1141’	0.40	fluffy mud
11/8/2005	JB11-05-54A	40° 36.7865’	73° 48.4226’	0.25	fluffy mud
11/8/2005	JB11-05-54B	40° 36.7865’	73° 48.4226’	0.26	fluffy mud
11/8/2005	JB11-05-54C	40° 36.7865’	73° 48.4226’	0.25	fluffy mud
11/19/2005	JB11-05-55	40° 36.0077’	73° 49.0073’	0.70	fine sand
11/8/2005	JB11-05-56	40° 35.6663’	73° 48.7098’	0.66	organic mud
11/8/2005	JB11-05-57	40° 36.0971’	73° 48.2916’	0.36	organic mud
11/19/2005	JB11-05-58	40° 36.2908’	73° 47.5875’	0.28	organic mud
11/19/2005	JB11-05-59	40° 36.0209’	73° 47.2605’	0.21	organic mud
11/19/2005	JB11-05-60	40° 36.6973’	73° 46.8184’	0.25	organic mud
11/19/2005	JB11-05-61	40° 37.1732’	73° 46.8403’	0.20	organic mud
11/19/2005	JB11-05-62	40° 37.2764’	73° 46.5788’	0.25	organic mud

Table B9. Continued.

Sample Date	Sample ID	Latitude (N)	Longitude (W)	Dry Bulk Density (0-5 cm) (g cm^{-3})	Sediment Description
11/19/2005	JB11-05-63	40° 36.9074’	73° 46.4500’	0.81	organic mud
11/19/2005	JB11-05-64	40° 37.4729’	73° 45.9020’	0.80	sand with shell hash
11/19/2005	JB11-05-65	40° 37.8447’	73° 45.2914’	0.25	organic mud

Table B10. November-2005 ^{210}Pb activity in subtidal samples.

SAMPLE ID	Total ^{210}Pb (dpm g^{-1})	Supported ^{210}Pb (dpm g^{-1})	$^{210}Pb_{xs}$ (dpm g^{-1})
JB11-05-1	6.5 ± 0.2	2.1 ± 0.1	4.3 ± 0.2
JB11-05-5	5.6 ± 0.2	1.8 ± 0.1	3.8 ± 0.2
JB11-05-6	5.7 ± 0.2	2.0 ± 0.1	3.7 ± 0.2
JB11-05-7	3.9 ± 0.2	1.4 ± 0.04	2.5 ± 0.2
JB11-05-8	5.2 ± 0.2	1.7 ± 0.1	3.5 ± 0.2
JB11-05-9	3.0 ± 0.1	2.0 ± 0.04	1.0 ± 0.2
JB11-05-10	6.1 ± 0.2	1.9 ± 0.1	4.2 ± 0.2
JB11-05-11	6.7 ± 0.1	2.0 ± 0.04	4.7 ± 0.1
JB11-05-12	6.2 ± 0.1	2.2 ± 0.03	4.0 ± 0.1
JB11-05-14	5.2 ± 0.2	1.2 ± 0.1	4.0 ± 0.2
JB11-05-15	6.6 ± 0.3	2.1 ± 0.1	4.5 ± 0.3
JB11-05-16	0.8 ± 0.1	0.7 ± 0.01	0.1 ± 0.1
JB11-05-17	2.3 ± 0.2	2.5 ± 0.1	-0.3 ± 0.2
JB11-05-18	6.3 ± 0.3	2.1 ± 0.1	4.2 ± 0.3
JB11-05-19	1.6 ± 0.1	1.5 ± 0.02	0.1 ± 0.1
JB11-05-20	1.6 ± 0.1	1.2 ± 0.03	0.4 ± 0.1
JB11-05-21	1.1 ± 0.1	1.4 ± 0.05	-0.3 ± 0.1
JB11-05-22	1.9 ± 0.1	1.8 ± 0.04	0.2 ± 0.1
JB11-05-23	6.8 ± 0.3	2.1 ± 0.1	4.7 ± 0.3
JB11-05-24	5.9 ± 0.3	2.3 ± 0.1	3.6 ± 0.3
JB11-05-25	1.8 ± 0.04	1.7 ± 0.03	0.1 ± 0.1
JB11-05-26	0.9 ± 0.1	0.6 ± 0.03	0.3 ± 0.1
JB11-05-27	7.2 ± 0.3	2.0 ± 0.1	5.2 ± 0.3
JB11-05-28	1.8 ± 0.1	1.7 ± 0.03	0.1 ± 0.1
JB11-05-29	7.0 ± 0.2	1.9 ± 0.04	5.1 ± 0.2
JB11-05-30	7.4 ± 0.2	2.0 ± 0.04	5.3 ± 0.2
JB11-05-31	7.2 ± 0.3	1.7 ± 0.1	5.5 ± 0.3
JB11-05-32	3.1 ± 0.2	1.4 ± 0.03	1.6 ± 0.2
JB11-05-33	6.6 ± 0.7	1.9 ± 0.1	4.7 ± 0.7
JB11-05-34	0.8 ± 0.1	1.1 ± 0.04	-0.3 ± 0.1
JB11-05-35A	6.8 ± 0.3	2.5 ± 0.1	4.3 ± 0.3
JB11-05-35B	5.6 ± 0.2	1.9 ± 0.1	3.7 ± 0.2
JB11-05-35C	6.5 ± 0.2	1.9 ± 0.1	4.6 ± 0.2
JB11-05-38	6.7 ± 0.2	1.6 ± 0.1	5.1 ± 0.2

Table B10. Continued.

SAMPLE ID	Total ^{210}Pb (dpm g^{-1})	Supported ^{210}Pb (dpm g^{-1})	$^{210}Pb_{xs}$ (dpm g^{-1})
JB11-05-40	6.6 ± 0.3	1.0 ± 0.1	5.6 ± 0.3
JB11-05-41	6.1 ± 0.2	2.0 ± 0.1	4.1 ± 0.2
JB11-05-42	6.1 ± 0.2	1.8 ± 0.1	4.3 ± 0.2
JB11-05-43	6.3 ± 0.3	1.9 ± 0.1	4.4 ± 0.3
JB11-05-44	5.0 ± 0.2	1.4 ± 0.1	3.6 ± 0.2
JB11-05-45	5.5 ± 0.2	1.6 ± 0.1	3.9 ± 0.2
JB11-05-46	6.1 ± 0.2	1.6 ± 0.1	4.5 ± 0.2
JB11-05-47	6.0 ± 0.3	1.4 ± 0.1	4.6 ± 0.3
JB11-05-48	5.3 ± 0.2	1.6 ± 0.1	3.7 ± 0.2
JB11-05-49	5.7 ± 0.2	1.6 ± 0.1	4.1 ± 0.3
JB11-05-50	4.0 ± 0.2	2.2 ± 0.1	1.8 ± 0.2
JB11-05-51	6.1 ± 0.2	1.4 ± 0.1	4.7 ± 0.3
JB11-05-52	6.0 ± 0.3	1.8 ± 0.1	4.2 ± 0.3
JB11-05-53	2.4 ± 0.2	2.2 ± 0.1	0.2 ± 0.2
JB11-05-54A	6.4 ± 0.2	1.8 ± 0.1	4.6 ± 0.2
JB11-05-54B	5.6 ± 0.1	1.6 ± 0.04	4.0 ± 0.2
JB11-05-54C	5.8 ± 0.2	1.8 ± 0.1	4.0 ± 0.2
JB11-05-55	5.6 ± 0.2	2.2 ± 0.05	3.4 ± 0.2
JB11-05-56	0.3 ± 0.1	0.6 ± 0.1	-0.3 ± 0.1
JB11-05-57	5.4 ± 0.2	1.8 ± 0.1	3.6 ± 0.2
JB11-05-58	5.8 ± 0.2	1.8 ± 0.1	4.0 ± 0.2
JB11-05-59	7.3 ± 0.3	1.8 ± 0.1	5.5 ± 0.3
JB11-05-60	6.7 ± 0.2	2.0 ± 0.1	4.7 ± 0.2
JB11-05-61	6.2 ± 0.3	1.6 ± 0.1	4.6 ± 0.3
JB11-05-62	6.5 ± 0.2	1.5 ± 0.1	5.0 ± 0.2
JB11-05-63	1.6 ± 0.1	1.1 ± 0.04	0.5 ± 0.2
JB11-05-64	3.2 ± 0.2	1.8 ± 0.04	1.4 ± 0.2
JB11-05-65	6.5 ± 0.1	1.5 ± 0.04	5.0 ± 0.1

Table B11. November-2005 234Th activities in subtidal samples.

Sample ID	Total ^{234}Th (dpm g^{-1})	Supported ^{234}Th (dpm g^{-1})	^{234}Th$_{xs}$ (dpm g^{-1})
JB11-05-1	2.6 ± 0.2	1.8 ± 0.3	0.7 ± 0.3
JB11-05-5	2.7 ± 0.3	2.2 ± 0.5	0.5 ± 0.6
JB11-05-6	2.3 ± 0.1	2.0 ± 0.3	0.3 ± 0.4
JB11-05-7	2.1 ± 0.2	2.1 ± 0.4	0.0 ± 0.4
JB11-05-8	2.2 ± 0.2	2.0 ± 0.4	0.2 ± 0.4
JB11-05-9	2.4 ± 0.1	1.6 ± 0.4	0.7 ± 0.4
JB11-05-10	4.2 ± 0.3	2.1 ± 0.3	2.1 ± 0.4
JB11-05-11	2.9 ± 0.1	2.0 ± 0.2	0.9 ± 0.2
JB11-05-12	2.7 ± 0.1	2.1 ± 0.2	0.6 ± 0.2
JB11-05-14	2.9 ± 0.2	2.1 ± 0.3	0.8 ± 0.4
JB11-05-15	2.5 ± 0.3	1.8 ± 0.2	0.7 ± 0.3
JB11-05-16	1.2 ± 0.1	0.6 ± 0.1	0.6 ± 0.1
JB11-05-17	2.4 ± 0.2	2.1 ± 0.3	0.3 ± 0.4
JB11-05-18	3.4 ± 0.3	1.7 ± 0.3	1.7 ± 0.4
JB11-05-19	1.7 ± 0.1	1.2 ± 0.2	0.5 ± 0.2
JB11-05-20	2.6 ± 0.2	1.3 ± 0.3	1.3 ± 0.4
JB11-05-21	1.5 ± 0.2	1.2 ± 0.4	0.3 ± 0.4
JB11-05-22	2.3 ± 0.2	1.5 ± 0.4	0.8 ± 0.4
JB11-05-23	5.0 ± 0.5	2.1 ± 0.3	2.9 ± 0.6
JB11-05-24	2.0 ± 0.2	1.5 ± 0.4	0.5 ± 0.4
JB11-05-25	1.3 ± 0.05	1.3 ± 0.03	0.0 ± 0.1
JB11-05-26	0.6 ± 0.1	0.4 ± 0.1	0.1 ± 0.1
JB11-05-27	3.0 ± 0.2	1.2 ± 0.2	1.8 ± 0.3
JB11-05-28	2.3 ± 0.2	1.2 ± 0.4	1.0 ± 0.5
JB11-05-29	4.3 ± 0.2	1.8 ± 0.2	2.5 ± 0.3
JB11-05-30	3.9 ± 0.2	1.6 ± 0.2	2.3 ± 0.3
JB11-05-31	2.0 ± 0.2	1.3 ± 0.2	0.7 ± 0.3
JB11-05-32	3.3 ± 0.2	1.5 ± 0.4	1.8 ± 0.4
JB11-05-33	0.4 ± 0.03	0.4 ± 0.03	0.0 ± 0.04
JB11-05-34	0.9 ± 0.1	0.6 ± 0.05	0.3 ± 0.1
JB11-05-35A	2.6 ± 0.3	2.0 ± 0.4	0.6 ± 0.5
JB11-05-35B	2.9 ± 0.2	1.8 ± 0.3	1.1 ± 0.4
JB11-05-35C	3.1 ± 0.2	1.5 ± 0.2	1.6 ± 0.3
JB11-05-38	4.0 ± 0.3	2.1 ± 0.3	1.9 ± 0.4

Table B11. Continued.

Sample ID	Total ^{234}Th (dpm g^{-1})	Supported ^{234}Th (dpm g^{-1})	$^{234}Th_{xs}$ (dpm g^{-1})
JB11-05-39	1.5 ± 0.2	1.3 ± 0.1	0.2 ± 0.3
JB11-05-40	3.3 ± 0.4	2.0 ± 0.2	1.3 ± 0.4
JB11-05-41	4.5 ± 0.3	1.5 ± 0.2	3.0 ± 0.4
JB11-05-42	4.7 ± 0.4	2.0 ± 0.3	2.7 ± 0.4
JB11-05-43	2.3 ± 0.3	2.2 ± 0.3	0.1 ± 0.4
JB11-05-44	3.4 ± 0.4	1.5 ± 0.2	1.9 ± 0.4
JB11-05-45	4.2 ± 0.3	2.3 ± 0.3	1.9 ± 0.4
JB11-05-46	3.0 ± 0.3	1.9 ± 0.1	1.2 ± 0.3
JB11-05-47	5.1 ± 0.5	1.6 ± 0.2	3.5 ± 0.5
JB11-05-48	4.4 ± 0.3	1.6 ± 0.1	2.8 ± 0.3
JB11-05-49	4.1 ± 0.5	1.8 ± 0.2	2.3 ± 0.5
JB11-05-50	4.3 ± 0.3	2.2 ± 0.4	2.1 ± 0.5
JB11-05-51	2.5 ± 0.2	0.1 ± 0.01	2.4 ± 0.2
JB11-05-52	4.8 ± 0.5	1.3 ± 0.2	3.5 ± 0.5
JB11-05-53	4.2 ± 0.4	1.6 ± 0.3	2.6 ± 0.5
JB11-05-54A	6.7 ± 0.3	1.7 ± 0.1	5.1 ± 0.4
JB11-05-54B	6.4 ± 0.3	1.8 ± 0.2	4.6 ± 0.3
JB11-05-54C	7.3 ± 0.4	2.2 ± 0.2	5.1 ± 0.5
JB11-05-55	4.1 ± 0.3	2.5 ± 0.6	1.6 ± 0.7
JB11-05-56	0.9 ± 0.3	0.7 ± 0.1	0.1 ± 0.3
JB11-05-57	6.8 ± 0.6	2.2 ± 0.4	4.6 ± 0.7
JB11-05-58	4.8 ± 0.4	1.4 ± 0.2	3.4 ± 0.4
JB11-05-59	7.6 ± 0.7	2.0 ± 0.2	5.7 ± 0.7
JB11-05-60	5.4 ± 0.4	2.1 ± 0.2	3.3 ± 0.5
JB11-05-61	3.1 ± 0.6	2.1 ± 0.2	1.0 ± 0.6
JB11-05-62	5.8 ± 0.4	1.7 ± 0.20	4.1 ± 0.4
JB11-05-63	3.8 ± 0.3	0.9 ± 0.1	3.0 ± 0.4
JB11-05-64	4.2 ± 0.4	2.0 ± 0.6	2.2 ± 0.7
JB11-05-65	7.2 ± 0.3	2.4 ± 0.2	4.8 ± 0.4

Table B12. Nov.-2005 $^{234}Th_{xs}$ and ^{7}Be subtidal inventories

SAMPLE ID	$^{234}Th_{xs}$ Inventory (dpm cm^{-2})	^{7}Be Inventory (dpm cm^{-2})
JB11-05-1	2.8 ± 1.3	22.9 ± 0.7
JB11-05-5	2.0 ± 1.9	28.8 ± 1.1
JB11-05-6	0.0 ± 1.0	9.1 ± 0.5
JB11-05-7	0.0 ± 2.2	20.5 ± 0.7
JB11-05-8	0.0 ± 1.6	4.1 ± 0.5
JB11-05-9	4.5 ± 2.4	2.6 ± 0.4
JB11-05-10	7.7 ± 1.8	5.8 ± 0.6
JB11-05-11	2.7 ± 0.6	27.6 ± 0.5
JB11-05-12	2.3 ± 0.9	5.0 ± 0.2
JB11-05-14	2.5 ± 1.2	4.6 ± 0.5
JB11-05-15	1.7 ± 0.8	14.6 ± 1.0
JB11-05-16	5.2 ± 1.0	1.5 ± 0.2
JB11-05-17	0.0 ± 2.4	2.8 ± 0.7
JB11-05-18	4.9 ± 1.1	5.8 ± 0.5
JB11-05-19	4.3 ± 1.8	2.4 ± 0.2
JB11-05-20	11.3 ± 3.5	2.2 ± 0.5
JB11-05-21	0.0 ± 3.5	0.0 ± 0.0
JB11-05-22	6.5 ± 3.4	3.2 ± 0.5
JB11-05-23	7.9 ± 1.7	11.6 ± 0.9
JB11-05-24	2.2 ± 1.8	0.2 ± 0.01
JB11-05-25	0.0 ± 0.5	0.0 ± 0.0
JB11-05-26	0.0 ± 0.9	0.0 ± 0.0
JB11-05-27	6.7 ± 1.2	9.7 ± 0.7
JB11-05-28	8.6 ± 3.9	2.0 ± 0.5
JB11-05-29	9.2 ± 1.1	7.1 ± 0.5
JB11-05-30	7.3 ± 1.0	2.8 ± 0.3
JB11-05-31	1.9 ± 0.7	4.3 ± 0.6
JB11-05-32	11.7 ± 2.7	5.6 ± 0.5
JB11-05-33	0.0 ± 0.3	0.1 ± 0.04
JB11-05-34	0.0 ± 1.2	0.0 ± 0.0
JB11-05-35A	2.1 ± 1.6	0.5 ± 0.1
JB11-05-35B	3.5 ± 1.2	2.9 ± 0.5
JB11-05-35C	5.0 ± 0.9	1.8 ± 0.4
JB11-05-38	5.0 ± 1.1	2.6 ± 0.7

Table B12. Continued.

SAMPLE ID	$^{234}Th_{xs}$ Inventory (dpm cm^{-2})	^{7}Be Inventory (dpm cm^{-2})
JB11-05-40	3.3 ± 1.0	1.0 ± 0.4
JB11-05-41	8.4 ± 1.1	2.9 ± 0.5
JB11-05-42	8.6 ± 1.4	0.0 ± 0.0
JB11-05-43	0.0 ± 1.1	3.8 ± 0.7
JB11-05-44	4.9 ± 1.1	0.2 ± 0.7
JB11-05-45	4.9 ± 1.2	1.9 ± 0.5
JB11-05-46	3.1 ± 0.8	0.9 ± 0.4
JB11-05-47	3.2 ± 0.5	0.0 ± 0.0
JB11-05-48	2.9 ± 0.3	0.0 ± 0.0
JB11-05-49	2.3 ± 0.5	0.0 ± 0.2
JB11-05-50	6.1 ± 1.4	1.8 ± 0.2
JB11-05-51	3.1 ± 0.2	1.7 ± 0.2
JB11-05-52	3.6 ± 0.5	3.1 ± 0.3
JB11-05-53	5.3 ± 0.9	2.7 ± 0.3
JB11-05-54A	6.3 ± 0.5	3.5 ± 0.2
JB11-05-54B	6.0 ± 0.4	2.8 ± 0.2
JB11-05-54C	6.4 ± 0.6	2.0 ± 0.2
JB11-05-55	5.4 ± 2.4	1.7 ± 0.3
JB11-05-56	0.0 ± 1.0	0.5 ± 0.6
JB11-05-57	8.3 ± 1.3	5.5 ± 0.4
JB11-05-58	4.8 ± 0.6	3.0 ± 0.3
JB11-05-59	5.8 ± 0.7	0.7 ± 0.3
JB11-05-60	4.0 ± 0.6	2.3 ± 0.2
JB11-05-61	1.0 ± 0.6	1.0 ± 0.3
JB11-05-62	5.1 ± 0.5	1.3 ± 0.2
JB11-05-63	12.1 ± 1.5	3.1 ± 0.6
JB11-05-64	8.8 ± 2.8	0.0 ± 0.0
JB11-05-65	6.1 ± 0.5	0.9 ± 0.2

Table B13. July-2006 sample site coordinates, dry bulk density and sediment description.

Sample Date	Sample ID	Latitude (N)	Longitude (W)	Dry Bulk Density (0-5 cm) (g cm^{-3})	Sediment Description
7/12/2006	JB7-06-1	40° 35.4960´	73° 51.0066´	1.42	sand
7/12/2006	JB7-06-2	40° 35.9043´	73° 50.9159´	1.60	silty sand
7/12/2006	JB7-06-3	40° 36.1808´	73° 50.5616´	0.51	organic mud
7/12/2006	JB7-06-4	40° 36.2603´	73° 50.1935´	1.25	silt mud with algae
7/12/2006	JB7-05-5	40° 35.9982´	73° 49.9825´	0.44	organic mud and ulva
7/12/2006	JB7-06-6	40° 36.0781´	73° 49.5478´	0.23	organic mud
7/12/2006	JB7-06-7	40° 36.3394´	73° 49.4128´	0.35	organic mud
7/12/2006	JB7-06-8	40° 36.2235´	73° 51.9263´	1.55	sand with shell hash
7/12/2006	JB7-06-9	40° 36.8437´	73° 51.7318´	1.55	sandy silt
7/12/2006	JB7-06-10	40° 37.0719´	73° 51.4704´	1.32	sand with shell hash
7/12/2006	JB7-06-11	40° 37.2186´	73° 50.7884´	1.50	silty sand
7/12/2006	JB7-06-12	40° 37.3664´	73° 50.3247´	1.33	sandy silt
7/12/2006	JB7-06-13	40° 38.0725´	73° 50.0173´	0.45	organic mud
7/12/2006	JB7-06-14	40° 38.3585´	73° 50.2401´	1.29	sand
7/12/2006	JB7-06-15	40° 38.4142´	73° 50.7259´	0.37	organic mud
7/12/2006	JB7-06-16	40° 38.4907´	73° 50.7019´	0.40	organic mud
7/12/2006	JB7-06-17	40° 38.5153´	73° 50.7348´	1.61	coarse sand
7/12/2006	JB7-06-18	40° 38.4714´	73° 51.0485´	0.51	organic mud
7/12/2006	JB7-06-19	40° 38.6246´	73° 51.2843´	0.65	organic mud
7/12/2006	JB7-06-20	40° 38.2928´	73° 51.8406´	0.47	organic mud with clams
7/12/2006	JB7-06-21	40° 38.0252´	73° 52.0579´	1.23	silty mud
7/12/2006	JB7-06-22	40° 38.0131´	73° 52.3654´	1.24	coarse sand
7/12/2006	JB7-06-23	40° 38.2626´	73° 52.6783´	0.62	mud
7/12/2006	JB7-06-24	40° 37.5771´	73° 52.9948´	0.64	clam shells
7/12/2006	JB7-06-25	40° 37.4189´	73° 53.2394´	0.62	organic mud
7/12/2006	JB7-06-26	40° 37.2256´	73° 53.3767´	0.64	mud with clams and worms
7/12/2006	JB7-06-27	40° 36.8679´	73° 53.1648´	0.58	organic mud
7/12/2006	JB7-06-28	40° 36.5434´	73° 52.9759´	0.77	organic mud
7/12/2006	JB7-06-29	40° 36.5428´	73° 52.4114´	1.44	sand
7/12/2006	JB7-06-30	40° 36.2706´	73° 52.7152´	0.89	sandy mud

Table B13. Continued.

Sample Date	Sample ID	Latitude (N)	Longitude (W)	Dry Bulk Density (0-5 cm) (g cm^{-3})	Sediment Description
7/12/2006	JB7-06-31	40° 35.9303´	73° 52.5663´	0.67	organic mud
7/12/2006	JB7-06-32	40° 35.7111´	73° 52.1488´	0.52	fluffy mud
7/12/2006	JB7-06-33	40° 35.4280´	73° 51.6161´	0.69	fluffy mud
7/12/2006	JB7-06-34	40° 35.1514´	73° 50.9735´	1.42	muddy sad
7/12/2006	JB7-06-35	40° 35.2840´	73° 49.5454´	1.63	sand
7/12/2006	JB7-06-36	40° 35.9980´	73° 49.0060´	0.55	organic mud
7/12/2006	JB7-06-37	40° 35.6626´	73° 48.7205´	1.59	sand
7/12/2006	JB7-06-38	40° 36.0967´	73° 48.3029´	0.65	organic mud
7/12/2006	JB7-06-39	40° 36.8590´	73° 48.1128´	0.73	organic mud
7/12/2006	JB7-06-40	40° 36.7817´	73° 48.4255´	0.36	fluffy mud
7/12/2006	JB7-06-41	40° 37.1289´	73° 48.5023´	0.34	fluffy mud
7/12/2006	JB7-06-42	40° 37.4930´	73° 48.5888´	0.30	fluffy mud
7/12/2006	JB7-06-43	40° 37.7885´	73° 48.6687´	0.57	fluffy mud
7/12/2006	JB7-06-44	40° 38.0259´	73° 49.0483´	0.32	fluffy mud
7/12/2006	JB7-06-45	40° 38.3281´	73° 49.2693´	0.25	fluffy mud
7/12/2006	JB7-06-46	40° 38.6595´	73° 49.2230´	0.41	fluffy mud
7/12/2006	JB7-06-47	40° 38.3223´	73° 48.8068´	0.41	fluffy mud
7/12/2006	JB7-06-48	40° 38.3221´	73° 48.7380´	0.35	fluffy mud
7/12/2006	JB7-06-49	40° 38.3126´	73° 48.6530´	0.32	fluffy mud
7/12/2006	JB7-06-50	40° 38.2298´	73° 48.6459´	0.27	fluffy mud
7/12/2006	JB7-06-51	40° 38.2084´	73° 48.4008´	0.31	fluffy mud
7/12/2006	JB7-06-52	40° 38.0384´	73° 48.5316´	0.26	fluffy mud
7/12/2006	JB7-06-53	40° 37.8088´	73° 47.9702´	0.35	fluffy mud
7/12/2006	JB7-06-54	40° 37.5570´	73° 47.6193´	0.22	fluffy mud
7/12/2006	JB7-06-55	40° 37.7134´	73° 47.3795´	0.23	fluffy mud
7/12/2006	JB7-06-57	40° 36.2936´	73° 47.5938´	0.32	fluffy mud
7/12/2006	JB7-06-58	40° 36.0247´	73° 47.2568´	0.22	fluffy mud
7/12/2006	JB7-06-59	40° 36.2670´	73° 47.1241´	0.33	fluffy mud
7/12/2006	JB7-06-60	40° 36.4731´	73° 47.1360´	0.37	fluffy mud
7/12/2006	JB7-06-61	40° 36.7007´	73° 46.8325´	0.35	fluffy mud

Table B13. Continued.

Sample Date	Sample ID	Latitude (N)	Longitude (W)	Dry Bulk Density (0-5 cm) (g cm^{-3})	Sediment Description
7/12/2006	JB7-06-62	40° 37.1743´	73° 46.8466´	0.23	fluffy mud
7/12/2006	JB7-06-64	40° 36.9070´	73° 46.4543´	0.99	mud with clams
7/12/2006	JB7-06-65	40° 37.4773´	73° 45.9054´	0.64	mud with clams
7/12/2006	JB7-06-66	40° 37.8421´	73° 45.2985´	0.33	fluffy mud

Table B14. July-2006 ^{210}Pb activities in subtidal samples.

SAMPLE ID	Total ^{210}Pb (dpm g^{-1})	Supported ^{210}Pb (dpm g^{-1})	$^{210}Pb_{xs}$ (dpm g^{-1})
JB7-06-1	1.8 ± 0.1	1.6 ± 0.04	0.1 ± 0.1
JB7-06-2	1.1 ± 0.1	0.8 ± 0.02	0.4 ± 0.1
JB7-06-3	6.2 ± 0.3	2.2 ± 0.1	4.0 ± 0.3
JB7-06-4	2.6 ± 0.1	2.1 ± 0.04	0.5 ± 0.1
JB7-05-5	6.1 ± 0.2	1.8 ± 0.1	4.3 ± 0.2
JB7-06-6	6.6 ± 0.6	1.6 ± 0.2	5.0 ± 0.7
JB7-06-7	8.6 ± 0.3	1.4 ± 0.1	7.2 ± 0.3
JB7-06-8	1.6 ± 0.2	1.4 ± 0.1	0.2 ± 0.2
JB7-06-9	1.4 ± 0.1	1.7 ± 0.04	-0.2 ± 0.1
JB7-06-10	2.5 ± 0.2	1.5 ± 0.04	1.0 ± 0.2
JB7-06-11	2.0 ± 0.1	2.0 ± 0.05	0.0 ± 0.2
JB7-06-12	1.8 ± 0.2	1.5 ± 0.1	0.3 ± 0.2
JB7-06-13	6.5 ± 0.2	2.2 ± 0.1	4.3 ± 0.3
JB7-06-13B	6.6 ± 0.3	1.7 ± 0.1	4.9 ± 0.3
JB7-06-14	1.7 ± 0.1	1.3 ± 0.03	0.4 ± 0.1
JB7-06-15	6.4 ± 0.3	2.3 ± 0.1	4.1 ± 0.3
JB7-06-16	8.2 ± 0.3	1.8 ± 0.1	6.4 ± 0.3
JB7-06-17	0.5 ± 0.1	0.5 ± 0.02	0.0 ± 0.1
JB7-06-18	6.9 ± 0.2	1.6 ± 0.04	5.4 ± 0.2
JB7-06-19	5.3 ± 0.1	2.0 ± 0.03	3.3 ± 0.2
JB7-06-20	12.8 ± 0.4	1.8 ± 0.1	10.9 ± 0.4
JB7-06-21	3.6 ± 0.2	1.4 ± 0.03	2.2 ± 0.2
JB7-06-22	1.3 ± 0.1	0.8 ± 0.02	0.5 ± 0.1
JB7-06-23	5.8 ± 0.2	1.5 ± 0.05	4.4 ± 0.3
JB7-06-24	6.5 ± 0.2	1.9 ± 0.1	4.5 ± 0.2
JB7-06-25	6.8 ± 0.2	1.7 ± 0.05	5.1 ± 0.2
JB7-06-26	5.9 ± 0.2	1.7 ± 0.05	4.2 ± 0.2
JB7-06-27	8.1 ± 0.2	1.7 ± 0.04	6.4 ± 0.3
JB7-06-28	5.6 ± 0.2	1.7 ± 0.04	3.9 ± 0.2
JB7-06-29	2.7 ± 0.3	2.9 ± 0.04	-0.3 ± 0.3
JB7-06-30	2.9 ± 0.2	1.6 ± 0.05	1.3 ± 0.2
JB7-06-31	6.0 ± 0.2	2.0 ± 0.05	4.0 ± 0.2
JB7-06-32	8.8 ± 0.3	1.9 ± 0.1	7.0 ± 0.3
JB7-06-33	6.5 ± 0.2	2.1 ± 0.05	4.5 ± 0.2

Table B14. Continued.

SAMPLE ID	Total ^{210}Pb (dpm g^{-1})	Supported ^{210}Pb (dpm g^{-1})	$^{210}Pb_{xs}$ (dpm g^{-1})
JB7-06-35	0.8 ± 0.1	0.8 ± 0.02	-0.1 ± 0.1
JB7-06-36	6.8 ± 0.2	2.5 ± 0.1	4.2 ± 0.3
JB7-06-37	0.4 ± 0.1	0.4 ± 0.01	0.0 ± 0.1
JB7-06-38	4.7 ± 0.2	1.6 ± 0.04	3.0 ± 0.2
JB7-06-39	3.1 ± 0.2	1.9 ± 0.04	1.2 ± 0.2
JB7-06-40	7.9 ± 0.3	1.6 ± 0.1	6.4 ± 0.3
JB7-06-41	8.5 ± 0.3	1.6 ± 0.1	6.9 ± 0.3
JB7-06-42	9.4 ± 0.4	1.6 ± 0.1	7.8 ± 0.4
JB7-06-43	5.9 ± 0.3	1.9 ± 0.1	4.1 ± 0.3
JB7-06-44	8.0 ± 0.4	1.8 ± 0.1	6.2 ± 0.4
JB7-06-45	8.9 ± 0.4	1.3 ± 0.1	7.5 ± 0.4
JB7-06-46	8.3 ± 0.3	1.9 ± 0.1	6.5 ± 0.3
JB7-06-47	10.1 ± 0.3	2.0 ± 0.1	8.1 ± 0.3
JB7-06-48	10.5 ± 0.3	1.5 ± 0.1	9.0 ± 0.4
JB7-06-49	11.2 ± 0.4	1.8 ± 0.1	9.4 ± 0.4
JB7-06-50	9.3 ± 0.4	1.6 ± 0.1	7.7 ± 0.4
JB7-06-51	12.6 ± 0.4	1.7 ± 0.1	10.8 ± 0.4
JB7-06-52	9.8 ± 0.4	1.4 ± 0.1	8.4 ± 0.4
JB7-06-53	8.0 ± 0.3	1.6 ± 0.1	6.4 ± 0.3
JB7-06-54	8.0 ± 0.5	1.8 ± 0.1	6.2 ± 0.5
JB7-06-55	8.1 ± 0.4	1.7 ± 0.1	6.4 ± 0.4
JB7-06-57	8.5 ± 0.3	1.6 ± 0.1	6.9 ± 0.3
JB7-06-58	11.5 ± 0.6	1.7 ± 0.1	9.8 ± 0.6
JB7-06-59	10.4 ± 0.4	1.8 ± 0.1	8.6 ± 0.4
JB7-06-60	9.3 ± 0.3	1.7 ± 0.1	7.5 ± 0.3
JB7-06-61	9.7 ± 0.3	1.7 ± 0.1	8.1 ± 0.3
JB7-06-62	9.6 ± 0.5	1.6 ± 0.1	8.0 ± 0.5
JB7-06-64	2.8 ± 0.1	1.5 ± 0.04	1.2 ± 0.1
JB7-06-65	4.1 ± 0.4	2.2 ± 0.1	1.8 ± 0.4
JB7-06-66	11.4 ± 0.3	1.6 ± 0.1	9.8 ± 0.4

Table B15. July-2006 ^{234}Th activities in subtidal samples.

Sample ID	Total ^{234}Th (dpm g^{-1})	Supported ^{234}Th (dpm g^{-1})	^{234}Th$_{xs}$ (dpm g^{-1})
JB7-06-1	1.3 ± 0.1	1.2 ± 0.1	0.1 ± 0.2
JB7-06-2	0.8 ± 0.1	0.6 ± 0.1	0.2 ± 0.1
JB7-06-3	3.7 ± 0.4	1.7 ± 0.1	2.0 ± 0.4
JB7-06-4	2.4 ± 0.1	2.0 ± 0.2	0.4 ± 0.2
JB7-05-5	2.8 ± 0.2	1.3 ± 0.1	1.5 ± 0.2
JB7-06-6	1.6 ± 0.3	1.8 ± 0.2	-0.2 ± 0.4
JB7-06-7	1.7 ± 0.2	1.6 ± 0.1	0.1 ± 0.2
JB7-06-8	1.3 ± 0.2	1.4 ± 0.1	-0.2 ± 0.3
JB7-06-9	1.3 ± 0.1	1.5 ± 0.1	-0.2 ± 0.1
JB7-06-10	1.8 ± 0.2	1.6 ± 0.1	0.1 ± 0.2
JB7-06-11	1.9 ± 0.2	1.8 ± 0.1	0.0 ± 0.2
JB7-06-12	1.4 ± 0.2	1.3 ± 0.1	0.1 ± 0.2
JB7-06-13	2.3 ± 0.2	1.7 ± 0.1	0.6 ± 0.2
JB7-06-14	1.4 ± 0.1	1.2 ± 0.1	0.3 ± 0.2
JB7-06-15	2.8 ± 0.2	2.0 ± 0.1	0.8 ± 0.2
JB7-06-16	2.4 ± 0.2	2.0 ± 0.1	0.5 ± 0.3
JB7-06-17	0.4 ± 0.1	0.3 ± 0.1	0.1 ± 0.1
JB7-06-18	2.0 ± 0.1	1.2 ± 0.1	0.9 ± 0.2
JB7-06-19	1.8 ± 0.1	1.5 ± 0.1	0.2 ± 0.1
JB7-06-20	1.9 ± 0.2	1.2 ± 0.1	0.7 ± 0.2
JB7-06-21	2.2 ± 0.2	1.2 ± 0.1	1.0 ± 0.2
JB7-06-22	1.2 ± 0.1	0.9 ± 0.1	0.3 ± 0.1
JB7-06-23	2.9 ± 0.2	1.4 ± 0.2	1.4 ± 0.3
JB7-06-24	4.8 ± 0.3	2.3 ± 0.2	2.5 ± 0.4
JB7-06-25	2.8 ± 0.2	2.3 ± 0.1	0.6 ± 0.3
JB7-06-26	3.2 ± 0.3	1.8 ± 0.1	1.4 ± 0.3
JB7-06-27	2.1 ± 0.2	2.0 ± 0.2	0.2 ± 0.2
JB7-06-28	2.5 ± 0.2	1.8 ± 0.2	0.7 ± 0.2
JB7-06-29	22.7 ± 1.5	22.1 ± 1.5	0.6 ± 2.2
JB7-06-30	1.2 ± 0.1	1.3 ± 0.1	-0.1 ± 0.2
JB7-06-31	3.5 ± 0.3	2.0 ± 0.2	1.5 ± 0.3
JB7-06-32	3.9 ± 0.4	2.1 ± 0.3	1.7 ± 0.5
JB7-06-33	3.3 ± 0.3	2.3 ± 0.2	1.1 ± 0.3
JB7-06-34	2.9 ± 0.2	1.0 ± 0.1	2.0 ± 0.2

Table B15. Continued

Sample ID	Total ^{234}Th (dpm g^{-1})	Supported ^{234}Th (dpm g^{-1})	^{234}Th$_{xs}$ (dpm g^{-1})
JB7-06-35	0.7 ± 0.1	0.8 ± 0.1	-0.1 ± 0.1
JB7-06-36	3.6 ± 0.2	1.1 ± 0.1	2.5 ± 0.2
JB7-06-37	0.5 ± 0.1	0.2 ± 0.04	0.3 ± 0.1
JB7-06-38	3.5 ± 0.2	1.9 ± 0.1	1.6 ± 0.3
JB7-06-39	5.2 ± 0.4	2.0 ± 0.2	3.2 ± 0.4
JB7-06-40	2.0 ± 0.2	1.2 ± 0.1	0.7 ± 0.2
JB7-06-41	3.4 ± 0.3	1.4 ± 0.1	2.0 ± 0.3
JB7-06-42	4.5 ± 0.4	2.1 ± 0.2	2.4 ± 0.5
JB7-06-43	4.9 ± 0.4	2.2 ± 0.2	2.7 ± 0.4
JB7-06-44	4.3 ± 0.4	2.1 ± 0.2	2.2 ± 0.4
JB7-06-45	4.2 ± 0.4	1.2 ± 0.1	3.1 ± 0.4
JB7-06-46	5.3 ± 0.3	2.1 ± 0.1	3.2 ± 0.4
JB7-06-47	3.9 ± 0.3	1.9 ± 0.1	2.0 ± 0.3
JB7-06-48	5.4 ± 0.4	1.3 ± 0.1	4.1 ± 0.4
JB7-06-49	4.8 ± 0.4	1.6 ± 0.1	3.2 ± 0.4
JB7-06-50	4.1 ± 0.5	1.7 ± 0.1	2.4 ± 0.5
JB7-06-51	5.7 ± 0.4	1.9 ± 0.2	3.8 ± 0.5
JB7-06-52	4.0 ± 0.4	1.6 ± 0.1	2.4 ± 0.4
JB7-06-53	4.1 ± 0.3	1.3 ± 0.1	2.8 ± 0.3
JB7-06-54	3.8 ± 0.5	1.0 ± 0.1	2.8 ± 0.5
JB7-06-55	4.4 ± 0.6	2.0 ± 0.2	2.4 ± 0.6
JB7-06-57	4.0 ± 0.3	1.4 ± 0.1	2.6 ± 0.3
JB7-06-58	6.2 ± 0.8	1.8 ± 0.3	4.3 ± 0.9
JB7-06-59	4.3 ± 0.4	1.2 ± 0.1	3.1 ± 0.4
JB7-06-60	5.1 ± 0.4	1.8 ± 0.1	3.4 ± 0.4
JB7-06-61	4.3 ± 0.3	1.1 ± 0.05	3.2 ± 0.3
JB7-06-62	5.4 ± 0.7	1.5 ± 0.2	3.9 ± 0.7
JB7-06-64	4.4 ± 0.3	1.8 ± 0.1	2.6 ± 0.3
JB7-06-65	3.9 ± 0.5	2.0 ± 0.2	1.9 ± 0.5
JB7-06-66	9.0 ± 0.6	1.8 ± 0.1	7.2 ± 0.6

Table B16. July-2006 $^{234}Th_{xs}$ and ^{7}Be inventories in subtidal samples.

SAMPLE ID	$^{234}Th_{xs}$ Inventory (dpm cm^{-2})	Be-7 Inventory (dpm cm^{-2})
JB7-06-1	0.0 ± 1.2	3.6 ± 0.4
JB7-06-2	0.0 ± 1.0	0.9 ± 0.3
JB7-06-3	5.1 ± 1.0	2.7 ± 0.4
JB7-06-4	2.4 ± 1.4	6.6 ± 0.5
JB7-05-5	3.4 ± 0.5	1.6 ± 0.2
JB7-06-6	0.0 ± 0.4	0.0 ± 0.0
JB7-06-7	0.0 ± 0.4	6.6 ± 0.4
JB7-06-8	0.0 ± 2.0	0.0 ± 0.0
JB7-06-9	0.0 ± 1.1	1.6 ± 0.4
JB7-06-10	0.0 ± 1.4	6.1 ± 0.6
JB7-06-11	0.0 ± 1.8	2.2 ± 0.5
JB7-06-12	0.0 ± 1.3	0.0 ± 0.0
JB7-06-13	1.3 ± 0.4	3.6 ± 0.3
JB7-06-14	0.0 ± 1.0	2.0 ± 0.4
JB7-06-15	1.4 ± 0.4	5.9 ± 0.3
JB7-06-16	1.0 ± 0.5	2.6 ± 0.3
JB7-06-17	0.0 ± 0.8	0.1 ± 0.3
JB7-06-18	2.2 ± 0.4	2.4 ± 0.2
JB7-06-19	0.0 ± 0.4	2.3 ± 0.2
JB7-06-20	1.7 ± 0.4	5.5 ± 0.3
JB7-06-21	6.2 ± 1.5	5.7 ± 0.4
JB7-06-22	0.0 ± 0.9	5.1 ± 0.4
JB7-06-23	4.5 ± 0.9	2.3 ± 0.4
JB7-06-24	8.0 ± 1.2	4.0 ± 0.4
JB7-06-25	1.7 ± 0.8	4.3 ± 0.4
JB7-06-26	4.4 ± 0.9	4.6 ± 0.4
JB7-06-27	0.0 ± 0.7	2.1 ± 0.3
JB7-06-28	2.8 ± 0.9	1.5 ± 0.3
JB7-06-29	4.6 ± 15.6	2.4 ± 0.4
JB7-06-30	0.0 ± 0.8	14.9 ± 0.7
JB7-06-31	5.0 ± 1.0	3.0 ± 0.3
JB7-06-32	4.6 ± 1.3	3.0 ± 0.5
JB7-06-33	3.7 ± 1.2	1.2 ± 0.3
JB7-06-34	14.0 ± 1.7	3.7 ± 0.5

Table B16. Continued.

SAMPLE ID	$^{234}Th_{xs}$ Inventory (dpm cm^{-2})	Be-7 Inventory (dpm cm^{-2})
JB7-06-35	0.0 ± 1.0	2.0 ± 0.3
JB7-06-36	6.9 ± 0.7	4.5 ± 0.4
JB7-06-37	0.0 ± 0.8	2.1 ± 0.3
JB7-06-38	5.2 ± 0.9	2.9 ± 0.4
JB7-06-39	11.5 ± 1.5	5.5 ± 0.4
JB7-06-40	1.3 ± 0.4	0.9 ± 0.3
JB7-06-41	3.3 ± 0.6	2.2 ± 0.3
JB7-06-42	3.7 ± 0.7	1.1 ± 0.3
JB7-06-43	7.6 ± 1.2	0.9 ± 0.4
JB7-06-44	3.5 ± 0.7	0.7 ± 0.3
JB7-06-45	3.8 ± 0.5	0.0 ± 0.0
JB7-06-46	6.7 ± 0.8	2.4 ± 0.4
JB7-06-47	4.2 ± 0.6	0.6 ± 0.2
JB7-06-48	7.2 ± 0.7	1.1 ± 0.3
JB7-06-49	5.1 ± 0.6	0.5 ± 0.3
JB7-06-50	3.1 ± 0.7	0.1 ± 0.2
JB7-06-51	6.0 ± 0.7	0.0 ± 0.0
JB7-06-52	3.2 ± 0.5	0.0 ± 0.0
JB7-06-53	5.0 ± 0.6	1.0 ± 0.3
JB7-06-54	3.0 ± 0.5	0.0 ± 0.0
JB7-06-55	2.8 ± 0.7	0.0 ± 0.0
JB7-06-57	4.2 ± 0.5	3.7 ± 0.4
JB7-06-58	4.8 ± 1.0	0.0 ± 0.0
JB7-06-59	5.3 ± 0.7	3.6 ± 0.4
JB7-06-60	6.2 ± 0.7	3.6 ± 0.3
JB7-06-61	5.7 ± 0.6	2.8 ± 0.3
JB7-06-62	4.5 ± 0.8	0.4 ± 0.4
JB7-06-64	12.9 ± 1.5	10.3 ± 0.6
JB7-06-65	6.1 ± 1.6	7.0 ± 0.6
JB7-06-66	12.0 ± 1.0	0.0 ± 0.0

B17. September-2004 marsh sample site coordinates, dry bulk density and location description.

Sample Date	Sample ID	Latitude (N)	Longitude (W)	Dry Bulk Density (0-5 cm) (g cm^{-3})	Marsh Island	Location Description
9/22/2004	JB9-04-64	40° 35.7877´	73° 51.4717´	0.6	Ruffle Bar	Dead Area
9/22/2004	JB9-04-65	40° 35.8767´	73° 51.2908´	1.5	Ruffle Bar	Tidal Creek Bed
9/22/2004	JB9-04-66	40° 35.9842´	73° 51.1230´	0.4	Ruffle Bar	High marsh, sparse vegetation, mussels
9/22/2004	JB9-04-67	40° 35.9857´	73° 51.1081´	1.2	Ruffle Bar	High marsh thick vegetation mat
9/22/2004	JB9-04-68	40° 36.0183´	73° 51.1288´	0.6	Ruffle Bar	Slumping margin, dense vegetation, mussels
9/22/2004	JB9-04-69	40° 35.5960´	73° 50.6227´	1.7	Little Egg	Marsh edge
9/22/2004	JB9-04-70	40° 35.6164´	73° 50.6074´	1.6	Little Egg	Area between marsh edge and tidal creek
9/22/2004	JB9-04-71	40° 35.6077´	73° 50.6062´	1.7	Little Egg	High marsh, In Alterniflora
9/22/2004	JB9-04-72	40° 35.6341´	73° 50.5930´	0.8	Little Egg	High marsh, In Alterniflora
9/22/2004	JB9-04-74	40° 35.6192´	73° 50.5698´	1.0	Little Egg	Dead area admist vegetative islands
9/22/2004	JB9-04-75	40° 35.6361´	73° 50.5249´	1.7	Little Egg	High standing, sandy marsh
9/22/2004	JB9-04-76	40° 35.6426´	73° 49.9404´	2.6	Little Egg	Edge of dredge spoil
9/22/2004	JB9-04-77	40° 35.6076´	73° 50.4303´	1.7	Little Egg	High, inner marsh
9/22/2004	JB9-04-78	40° 37.2088´	73° 51.1595´	0.4	Duck Point	Marsh edge
9/22/2004	JB9-04-79	40° 37.2088´	73° 51.1588´	0.6	Duck Point	Dead area
9/22/2004	JB9-04-82	40° 37.2326´	73° 51.1556´	0.4	Duck Point	Marsh edge
9/22/2004	JB9-04-83	40° 37.4687´	73° 48.0153´	0.3	East High	Marsh edge
9/22/2004	JB9-04-84	40° 37.4709´	73° 48.0131´	0.2	East High	Dead area, lots of Ulva,
9/22/2004	JB9-04-85	40° 37.4838´	73° 48.0044´	0.3	East High	Dead area, lots of Ulva,
9/22/2004	JB9-04-86	40° 37.5100´	73° 48.0288´	0.2	East High	Dead area
9/22/2004	JB9-04-87	40° 37.2985´	73° 47.7112´	0.3	JoCo	Edge of marsh
9/22/2004	JB9-04-88	40° 37.2994´	73° 47.6864´	0.2	JoCo	Just interior from edge
9/22/2004	JB9-04-89	40° 37.3063´	73° 47.6799´	0.9	JoCo	Edge of creek
9/22/2004	JB9-04-90	40° 37.2933´	73° 47.6787´	0.1	JoCo	Mid-marsh

B18. September-2004 ^{210}Pb activities in surficial (0-5 cm) marsh samples.

Sample ID	Total ^{210}Pb (dpm g^{-1})	Supported ^{210}Pb (dpm g^{-1})	$^{210}Pb_{xs}$ (dpm g^{-1})
JB9-04-64	7.5 ± 0.3	0.5 ± 0.02	7.0 ± 0.3
JB9-04-65	2.0 ± 0.1	0.5 ± 0.01	1.5 ± 0.1
JB9-04-66	9.7 ± 0.4	0.5 ± 0.03	9.2 ± 0.4
JB9-04-67	1.7 ± 0.1	0.7 ± 0.02	1.1 ± 0.1
JB9-04-68	4.9 ± 0.3	0.6 ± 0.03	4.3 ± 0.3
JB9-04-69	1.6 ± 0.1	0.6 ± 0.01	1.1 ± 0.1
JB9-04-70	1.4 ± 0.1	0.7 ± 0.01	0.7 ± 0.1
JB9-04-71	1.9 ± 0.1	0.5 ± 0.01	1.3 ± 0.1
JB9-04-72	3.3 ± 0.2	1.0 ± 0.02	2.3 ± 0.2
JB9-04-74	2.8 ± 0.1	0.7 ± 0.02	2.2 ± 0.1
JB9-04-75	1.0 ± 0.1	0.2 ± 0.01	0.7 ± 0.1
JB9-04-76	1.0 ± 0.1	0.3 ± 0.01	0.7 ± 0.1
JB9-04-77	1.1 ± 0.1	0.3 ± 0.01	0.8 ± 0.1
JB9-04-78	3.2 ± 0.2	0.5 ± 0.02	2.7 ± 0.2
JB9-04-79	2.8 ± 0.1	0.6 ± 0.02	2.2 ± 0.1
JB9-04-82	3.3 ± 0.2	0.6 ± 0.01	2.7 ± 0.2
JB9-04-83	2.3 ± 0.3	0.5 ± 0.03	1.8 ± 0.3
JB9-04-84	4.5 ± 0.4	0.4 ± 0.03	4.1 ± 0.4
JB9-04-85	2.9 ± 0.3	0.3 ± 0.02	2.6 ± 0.3
JB9-04-86	7.3 ± 0.4	0.3 ± 0.03	7.0 ± 0.4
JB9-04-87	6.9 ± 0.5	1.1 ± 0.06	5.9 ± 0.5
JB9-04-88	18.8 ± 0.8	0.5 ± 0.06	13.3 ± 0.8
JB9-04-89	4.2 ± 0.2	0.1 ± 0.01	4.1 ± 0.2
JB9-04-90	21.3 ± 1.0	0.3 ± 0.06	13.2 ± 1.0

B19. September-2004 ^{234}Th activities in surficial (0-5 cm) marsh samples.

SAMPLE ID	Total ^{234}Th Activity (dpm g^{-1})	Supported ^{234}Th Activity (dpm g^{-1})	^{234}Th$_{xs}$ Activity (dpm g^{-1})
JB9-04-64	2.5 ± 0.4	1.6 ± 0.2	0.9 ± 0.5
JB9-04-65	2.9 ± 0.3	1.8 ± 0.1	1.2 ± 0.3
JB9-04-66	3.7 ± 0.4	2.2 ± 0.3	1.5 ± 0.5
JB9-04-67	2.6 ± 0.2	1.5 ± 0.1	1.1 ± 0.2
JB9-04-68	4.7 ± 0.6	1.8 ± 0.1	2.9 ± 0.6
JB9-04-69	2.4 ± 0.2	1.3 ± 0.1	1.1 ± 0.2
JB9-04-70	5.4 ± 0.4	1.8 ± 0.1	3.6 ± 0.4
JB9-04-71	3.5 ± 0.3	1.6 ± 0.1	2.0 ± 0.3
JB9-04-72	2.3 ± 0.2	1.8 ± 0.2	0.5 ± 0.3
JB9-04-74	2.6 ± 0.1	1.7 ± 0.1	0.9 ± 0.2
JB9-04-75	1.1 ± 0.2	0.8 ± 0.1	0.3 ± 0.2
JB9-04-76	0.7 ± 0.1	0.9 ± 0.1	-0.1 ± 0.2
JB9-04-77	1.0 ± 0.1	0.9 ± 0.04	0.1 ± 0.1
JB9-04-78	9.3 ± 0.5	1.6 ± 0.1	7.7 ± 0.5
JB9-04-79	2.9 ± 0.2	1.4 ± 0.1	1.5 ± 0.2
JB9-04-82	1.3 ± 0.1	1.4 ± 0.1	-0.1 ± 0.1
JB9-04-83	7.3 ± 0.5	1.1 ± 0.1	6.1 ± 0.5
JB9-04-84	3.7 ± 0.1	0.1 ± 0.01	3.6 ± 0.1
JB9-04-85	3.6 ± 0.3	1.0 ± 0.1	2.5 ± 0.3
JB9-04-86	2.5 ± 0.3	1.5 ± 0.2	1.0 ± 0.4
JB9-04-87	8.3 ± 0.9	1.9 ± 0.3	6.3 ± 0.9
JB9-04-88	9.5 ± 1.3	1.8 ± 0.1	7.7 ± 1.3
JB9-04-89	1.8 ± 0.7	1.7 ± 0.1	0.2 ± 0.7
JB9-04-90	4.0 ± 0.6	2.0 ± 0.2	2.0 ± 0.6

B20. September-2004 $^{234}Th_{xs}$ and ^{7}Be inventories in marsh samples (0-5cm).

SAMPLE ID	$^{234}Th_{xs}$ Inventory (dpm cm^{-2})	Be-7 Inventory (dpm cm^{-2})
JB9-04-64	2.8 ± 1.5	2.1 ± 0.2
JB9-04-65	9.1 ± 2.4	2.0 ± 0.1
JB9-04-66	3.0 ± 1.0	3.1 ± 0.3
JB9-04-67	7.0 ± 1.3	2.0 ± 0.1
JB9-04-68	8.4 ± 1.8	4.1 ± 0.3
JB9-04-69	9.4 ± 1.8	1.1 ± 0.1
JB9-04-70	12.8 ± 3.4	0.4 ± 0.1
JB9-04-71	12.5 ± 2.8	0.6 ± 0.1
JB9-04-72	1.8 ± 1.1	0.6 ± 0.1
JB9-04-74	4.9 ± 0.9	1.6 ± 0.1
JB9-04-75	0.0 ± 1.6	1.7 ± 0.1
JB9-04-76	0.0 ± 2.0	1.8 ± 0.05
JB9-04-77	0.0 ± 1.2	0.3 ± 0.03
JB9-04-78	16.1 ± 1.0	2.0 ± 0.3
JB9-04-79	4.7 ± 0.6	3.9 ± 0.1
JB9-04-82	0.0 ± 0.2	0.0 ± 0.1
JB9-04-83	9.8 ± 0.8	1.3 ± 0.4
JB9-04-84	3.6 ± 0.1	1.2 ± 0.3
JB9-04-85	3.8 ± 0.5	1.4 ± 0.1
JB9-04-86	1.0 ± 0.4	4.1 ± 0.4
JB9-04-87	6.3 ± 1.2	4.1 ± 0.6
JB9-04-88	6.1 ± 1.0	4.2 ± 0.8
JB9-04-89	0.0 ± 3.1	1.2 ± 0.1
JB9-04-90	1.4 ± 0.4	4.3 ± 0.9

B21. May-2005 marsh sample site coordinates, dry bulk density and location description.

Sample Date	Sample ID	Latitude (N)	Longitude (W)	Dry Bulk Density (0-5 cm) (g cm^{-3})	Marsh Island	Location Description
5/24/2005	JB5-05-59	40° 35.7845´	73° 49.5387´	0.2	Big Egg	Next to dead area
5/24/2005	JB5-05-60	40° 35.7905´	73° 49.5486´	0.3	Big Egg	Dead area
5/24/2005	JB5-05-61	40° 35.7868´	73° 49.5543´	0.3	Big Egg	Vegetated area near restoration site
5/24/2005	JB5-05-62	40°.35.8005´	73° 49.6271´	0.8	Big Egg	Creek bank
5/24/2005	JB5-05-63	40° 35.8054´	73° 49.6256´	0.4	Big Egg	High, dead area
5/24/2005	JB5-05-64	40° 38.0241´	73° 51.1782´	1.0	Elders Point	Intertidal area, lots of ulva
5/24/2005	JB5-05-65	40° 37.9967´	73° 51.1957´	1.1	Elders Point	Intertidal area, lots of ulva
5/24/2005	JB5-05-66	40° 37.8700´	73° 51.1723´	1.4	Elders Point	Vegetated, low area
5/24/2005	JB5-05-68	40° 37.8880´	73° 51.2755´	1.7	Elders Point	Sandy area
5/24/2005	JB5-05-69	40° 37.1031´	73° 47.8268´	1.6	JoCo	Intertidal area
5/24/2005	JB5-05-70	40° 37.0935´	73° 47.8001´	0.3	JoCo	Intertidal area adjacent to vegetation
5/24/2005	JB5-05-71	40° 37.0724´	73 47.7501´	0.3	JoCo	Dense vegetation
5/24/2005	JB5-05-72	40° 37.0622´	73° 47.6991´	0.3	JoCo	Dense vegetation
5/24/2005	JB5-05-73	40° 37.0322´	73° 47.6685´	0.2	JoCo	salt flat with Salicornia
5/24/2005	JB5-05-74	40° 36.9988´	73° 47.6889´	0.2	JoCo	Vegetation next to ditch
5/24/2005	JB5-05-75	40° 36.9757´	73° 47.7979´	0.2	JoCo	Tidal Creek Bed
5/24/2005	JB5-05-76	40° 36.9782´	73° 47.7283´	0.3	JoCo	Vegetated area
5/24/2005	JB5-05-77	40° 37.3933´	73° 48.0904´	0.4	East High	Spartina area
5/24/2005	JB5-05-78	40° 37.4022´	73° 48.1130´	0.2	East High	Near tidal channel
5/24/2005	JB5-05-79	40° 37.4314´	73° 48.1628´	0.4	East High	Intertidal
5/24/2005	JB5-05-81	40° 36.3421´	73° 50.4810´	0.2	Yellow Bar	Intertidal area
5/24/2005	JB5-05-82	40° 36.3402´	73° 50.5141´	0.3	Yellow Bar	Edge of ponding area
5/24/2005	JB5-05-83	40° 36.3232´	73° 50.5410´	0.5	Yellow Bar	In ponded area
5/24/2005	JB5-05-85	40° 35.3252´	73° 50.1438´	1.7	Little Egg	Vegetated area
5/24/2005	JB5-05-86	40° 35.3371´	73° 50.1471´	1.7	Little Egg	Between vegetated area and dredge spoil
5/24/2005	JB5-05-87	40° 35.3674´	73° 50.1444´	1.6	Little Egg	Vegetated area

B22. May-2005 ^{210}Pb activities in surficial (0-5 cm) marsh samples.

Sample ID	Total ^{210}Pb (dpm g^{-1})	Supported ^{210}Pb (dpm g^{-1})	$^{210}Pb_{xs}$ (dpm g^{-1})
JB5-05-59	9.4 ± 0.4	1.1 ± 0.1	8.4 ± 0.4
JB5-05-60	8.8 ± 0.4	1.0 ± 0.1	7.7 ± 0.4
JB5-05-61	19.4 ± 0.6	2.7 ± 0.1	16.7 ± 0.6
JB5-05-62	4.0 ± 0.2	1.5 ± 0.04	2.5 ± 0.2
JB5-05-63	6.8 ± 0.3	1.1 ± 0.1	5.6 ± 0.3
JB5-05-64	1.8 ± 0.1	2.0 ± 0.04	-0.2 ± 0.1
JB5-05-65	2.7 ± 0.1	2.2 ± 0.04	0.6 ± 0.2
JB5-05-66	1.1 ± 0.1	1.4 ± 0.03	-0.2 ± 0.1
JB5-05-68	0.6 ± 0.1	0.6 ± 0.02	0.0 ± 0.1
JB5-05-69	17.3 ± 1.2	15.3 ± 0.3	2.0 ± 1.3
JB5-05-70	1.8 ± 0.1	1.9 ± 0.03	-0.1 ± 0.1
JB5-05-71	2.8 ± 0.3	1.1 ± 0.1	1.7 ± 0.3
JB5-05-72	8.8 ± 0.5	0.6 ± 0.1	8.2 ± 0.5
JB5-05-73	3.3 ± 0.3	0.8 ± 0.1	2.5 ± 0.3
JB5-05-74	8.0 ± 0.4	1.0 ± 0.1	7.1 ± 0.4
JB5-05-75	4.2 ± 0.3	1.3 ± 0.1	2.9 ± 0.3
JB5-05-76	7.6 ± 0.3	1.0 ± 0.1	6.6 ± 0.3
JB5-05-77	10.2 ± 0.5	2.6 ± 0.1	7.7 ± 0.5
JB5-05-78	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0
JB5-05-79	2.4 ± 0.3	1.5 ± 0.05	0.9 ± 0.3
JB5-05-81	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0
JB5-05-82	5.1 ± 0.3	2.0 ± 0.1	3.1 ± 0.3
JB5-05-83	1.8 ± 0.2	1.4 ± 0.1	0.4 ± 0.3
JB5-05-85	0.0 ± 0.0	0.1 ± 0.01	-0.1 ± 0.01
JB5-05-86	0.0 ± 0.0	0.1 ± 0.01	-0.1 ± 0.01
JB5-05-87	0.7 ± 0.04	0.7 ± 0.01	0.0 ± 0.05

B23. May-2005 ^{234}Th activities in surficial (0-5 cm) marsh samples.

SAMPLE ID	Total ^{234}Th Activity (dpm g^{-1})	Supported ^{234}Th Activity (dpm g^{-1})	$^{234}Th_{xs}$ Activity (dpm g^{-1})
JB5-05-59	4.4 ± 0.6	4.2 ± 0.4	0.2 ± 0.7
JB5-05-60	3.7 ± 0.5	4.0 ± 0.3	-0.3 ± 0.6
JB5-05-61	12.7 ± 0.8	9.3 ± 0.3	3.4 ± 0.9
JB5-05-62	2.4 ± 0.2	1.5 ± 0.1	0.9 ± 0.3
JB5-05-63	5.0 ± 0.4	2.7 ± 0.2	2.3 ± 0.5
JB5-05-64	2.6 ± 0.3	2.6 ± 0.1	0.0 ± 0.3
JB5-05-65	2.1 ± 0.2	2.3 ± 0.1	-0.2 ± 0.2
JB5-05-66	0.3 ± 0.02	0.4 ± 0.02	-0.2 ± 0.02
JB5-05-68	0.2 ± 0.03	0.5 ± 0.1	-0.2 ± 0.1
JB5-05-69	1.6 ± 0.1	1.5 ± 0.1	0.1 ± 0.2
JB5-05-70	14.3 ± 0.7	1.2 ± 0.1	13.1 ± 0.7
JB5-05-71	8.0 ± 0.4	8.3 ± 0.3	-0.3 ± 0.5
JB5-05-72	2.5 ± 0.1	2.3 ± 0.1	0.1 ± 0.2
JB5-05-73	6.0 ± 1.0	5.4 ± 0.5	0.6 ± 1.1
JB5-05-74	8.4 ± 0.5	8.7 ± 0.5	-0.3 ± 0.7
JB5-05-75	5.6 ± 0.4	5.8 ± 0.3	-0.2 ± 0.5
JB5-05-76	4.9 ± 0.5	5.2 ± 0.2	-0.2 ± 0.6
JB5-05-77	5.6 ± 0.3	5.9 ± 0.3	-0.3 ± 0.4
JB5-05-78	4.7 ± 0.3	4.7 ± 0.2	-0.1 ± 0.3
JB5-05-79	4.3 ± 0.2	4.4 ± 0.3	-0.1 ± 0.4
JB5-05-81	24.9 ± 1.3	14.6 ± 0.6	10.2 ± 1.4
JB5-05-82	11.9 ± 0.8	8.2 ± 0.6	3.8 ± 1.0
JB5-05-83	11.0 ± 0.7	4.1 ± 0.7	6.9 ± 1.0
JB5-05-85	0.8 ± 0.05	0.9 ± 0.1	-0.1 ± 0.1
JB5-05-86	0.8 ± 0.1	1.1 ± 0.3	-0.2 ± 0.3
JB5-05-87	1.4 ± 0.1	0.6 ± 0.1	0.8 ± 0.1

B24. May-2005 $^{234}Th_{xs}$ and ^{7}Be inventories in marsh samples (0-5 cm).

SAMPLE ID	$^{234}Th_{xs}$ Inventory (dpm cm^{-2})	^{7}Be Inventory (dpm cm^{-2})
JB5-05-59	0.0 ± 0.7	1.1 ± 0.3
JB5-05-60	0.0 ± 0.8	0.4 ± 0.4
JB5-05-61	4.2 ± 1.1	0.5 ± 0.3
JB5-05-62	3.8 ± 1.1	2.1 ± 0.3
JB5-05-63	4.8 ± 1.0	5.6 ± 0.4
JB5-05-64	0.0 ± 1.3	1.1 ± 0.3
JB5-05-65	0.0 ± 1.1	0.1 ± 0.03
JB5-05-66	0.0 ± 0.2	1.1 ± 0.5
JB5-05-68	0.0 ± 0.7	4.9 ± 2.5
JB5-05-69	0.0 ± 1.3	0.0 ± 0.0
JB5-05-70	19.7 ± 1.1	0.5 ± 0.2
JB5-05-71	0.0 ± 0.7	0.6 ± 0.2
JB5-05-72	0.0 ± 0.2	13.0 ± 2.4
JB5-05-73	0.6 ± 1.2	1.5 ± 0.3
JB5-05-74	0.0 ± 0.8	1.2 ± 0.2
JB5-05-75	0.0 ± 0.6	0.6 ± 0.2
JB5-05-76	0.0 ± 1.0	2.4 ± 0.7
JB5-05-77	0.0 ± 0.7	2.2 ± 0.3
JB5-05-78	0.0 ± 0.4	1.3 ± 0.3
JB5-05-79	0.0 ± 0.7	0.4 ± 0.1
JB5-05-81	10.2 ± 1.4	0.0 ± 0.0
JB5-05-82	5.6 ± 1.5	1.9 ± 0.4
JB5-05-83	15.9 ± 2.2	0.5 ± 0.1
JB5-05-85	0.0 ± 0.7	0.5 ± 0.1
JB5-05-86	0.0 ± 2.6	1.0 ± 0.2
JB5-05-87	6.3 ± 1.0	0.6 ± 0.2

The Department of the Interior protects and manages the nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its special responsibilities to American Indians, Alaska Natives, and affiliated Island Communities.

NPS 646/102095, May 2010

National Park Service
U.S. Department of the Interior

Natural Resource Program Center
1201 Oakridge Drive, Suite 150
Fort Collins, CO 80525

www.nature.nps.gov

EXPERIENCE YOUR AMERICA ™